International Marine Engineering

JUNE, 1908.

THE FRENCH ARMORED CRUISER EDGAR QUINET.

BY J. G. PELTIER.

The largest armored cruiser ever built on the continent of Europe was launched from Brest dockyard on Sept. 21, 1907. Her dimensions are as follows: Length over all, 515 feet 10 inches; extreme beam, 70 feet 7 inches; gross trial draft, 27 feet 4 inches; displacement at same draft, 14,158 tons; bunker coal carried on trials, 1,242 tons; designed speed for 10 hours, 23 knots.

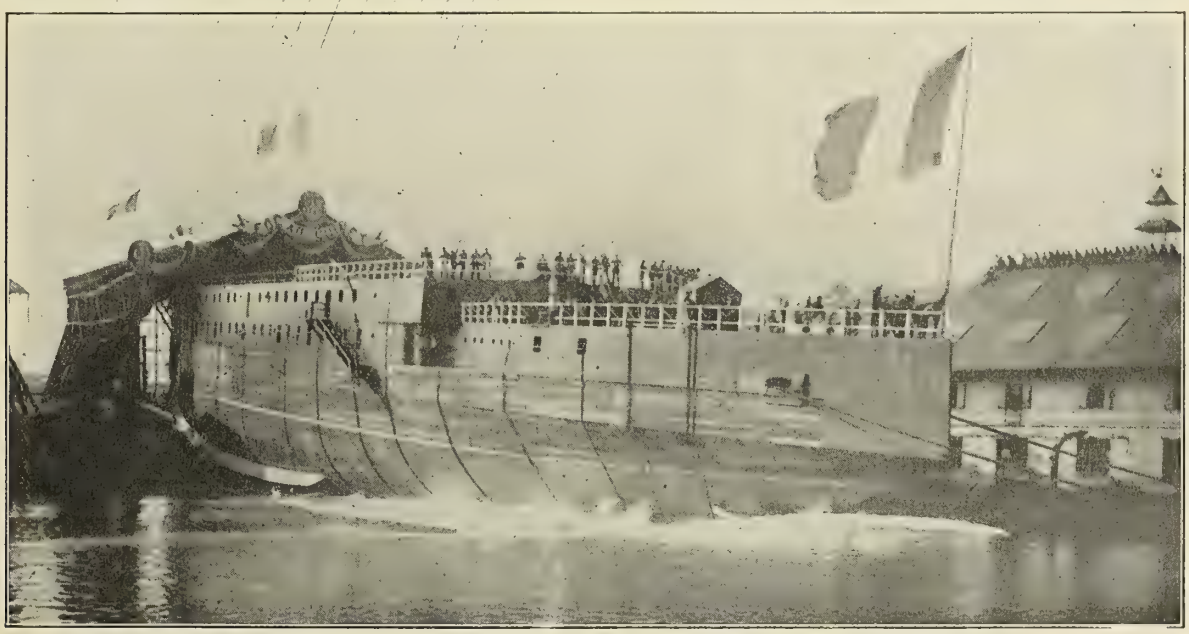
The hull is of steel throughout, and is fitted with bilge keels, well shown in the photograph of her launching. Her protection consists of a complete belt of armor, 12 feet 2 inches wide amidships (7 feet 7 inches above waterline), and having a maximum of thickness of 6¾ inches amidships on about two-thirds of the ship's length. Gradually the thickness decreases from the middle of the hull to stem and stern, where it is only 4 inches forward and 3 inches aft. The thickness is also reduced from the waterline to the opposite edges of the two strakes of the belt side armor. Forward, there is a third strake running from stem to the forward casemates. Two armor athwartship bulkheads are worked from the shell plating at the ends of the casemates to the center barbettes of the 7.6-inch guns; they are made of 6¾-inch plating.

There are two protective decks, extending from stem to stern; the lower one is flat amidships and sloped at side and ends. The thickness is of 2 9/16 inches on the slopes and 1 19/24 inches on the flat. The upper one is flat and of 1⅜ inches. These two decks have their axis at the edges of the belt side armor. The side protection is completed with a cofferdam extending from the lower to the upper protective deck and a watertight bulkhead behind this cofferdam. Teak backing is fitted behind all the side armor. The conning tower has 8 inches thickness and the armor tube 5 inches..

Above the protective decks are the gun deck, worked from end to end, and the spar deck, running from stem to the after 7.6-inch turret. Above this deck are numerous bridges. As usual, the space between the belt side armor, the watertight bulkhead and cofferdam, and the two protective decks is divided by numerous compartments, filled with stores or water-excluding materials. Passages of any kind going through this space are protected with an annular cofferdam extending from foot to top.

The armament will be the most powerful of this type of cruiser in the French navy, but will be far less powerful than the usual armament of similar cruisers of the other leading naval powers. The battery will be mounted as follows: Four 7.64-inch guns in two electrically-operated elliptical turrets on the center line, one forward, one aft; they have an arc of fire of about 280 degrees; six 7.64-inch guns in six electrically operated, elliptical turrets on the spar deck, three on each side, like on the latest French battleships of the *Démocratie* type, and four 7.64-inch guns in four casements, two forward and two aft (fourteen such guns, in all).

The turrets will have front and rear plates, 6.3 inches; splinter plates, 4.8 inches; top plates, 1.5 inches. The barbettes have front and rear plates, 6.3 inches; floor plates, 1.6 inches; inner tube, 1.2 to 3.2 inches; exterior tube, 19/24 inch. The casemates are formed with outside plating of 6.3 inches; inside plating, 4 inches; splinter plates, 5.5 inches; floor and top plates 19/24 inch.



THE LAUNCHING OF THE FRENCH ARMORED CRUISER EDGAR QUINET.

The casemate guns are arranged to fire right ahead or astern, respectively. There will also be six 3-pounder guns on the gun deck; ten of the same on the spar deck, and eight on the bridges. Two 18-inch submerged torpedo tubes will be also fitted, forward. The main fire will consist of eight 7.64-inch guns forward or aft, and nine in broadside.

All ammunition rooms adjacent to heated compartments will be arranged with air spaces, and, since the disaster to the *Iena,* with refrigerating machinery. They are so arranged that about one-half of the ammunition will be carried at each end of the ship. The ammunition will be handled by hoists, trolleys and tracks, driven by electric motors.

The main engines consist of three sets of triple expansion, four-cylinder engines, having a total indicated horsepower of 36,000, and driving three propellers. Each engine will be located in a separate watertight compartment. The steam will be supplied to the main and auxiliary engines by Belleville watertube boilers, placed in two sets in several watertight compartments. The boilers will discharge the products of combustion into six funnels, 73 feet high above the base line, and 22 feet in diameter; three are forward and three aft.

The coal bunkers will have a maximum capacity of about 2,300 tons. With the ordinary bunker filling of 1,242 tons, the steaming radius will be at 10 knots, 6,000 nautical miles, and with the full bunkers, 10,000 miles. A certain quantity of liquid fuel may be shipped in the double bottom.

All compartments below the upper protective deck, except the coal bunkers, are fitted with forced draft. Special attention will be paid to spaces subject to habitually high temperature, such as engine, boiler and dynamo rooms. All blowers, except for the forced draft, are electrically operated. There are six dynamos.

There will be two lower bridges, forward and aft, chart houses and a flying bridge forward only. There are two steel masts, the forward one having a signal yard. There will be six searchlights, two in the masts, two forward and two aft. The two hawse pipes are so designed that stockless anchors will be stowed in them. The crew will be composed of thirty officers and 708 men.

	Edgar Quinet. France.	*Montana.* U. S. A.	*Shannon.* England.
Displacement	14,158	14,500	14,600
Horsepower	36,000	25,000	28,500
Speed, knots.....	23	22	22.6
Admiralty coefficient..	198	246.5	242
Main battery.....	14–7.64″	4–10″	4–9.2″
	.....	16–6″	10–7.5″
Armor belt.....	6.7″	5″	6″
Broadside, pounds.....	1,665	2,900	2,520
Coal, tons.....	2,300	2,000	2,000

SAIL MAKING.

BY ADRIAN WILSON.

Fig. 3 shows a fore-and-aft sail with the proper names of the different sides indicated, also the proper names of the different corners of the sail. Of the different arrangements of cloths which have been used in fore-and-aft sails, the two most used are shown in Figs. 3 and 4. Fig. 3 indicates the old arrangement of cloths, with seams running parallel to after leach; Fig. 4 indicates the present or crosscut arrangement of cloths, with seams arranged at right angle to after leach.

In headsails, Figs. 5 and 6 show old arrangement of cloths; Fig. 7 shows the new arrangement. We have also found cloths arranged in headsails in different forms as shown in Figs. 8, 9 and 10.

The tendency to stretch has always been greater in headsails than in the other sails. What our mothers and the seamstress would call a bias in a piece of cloth, sailmakers know

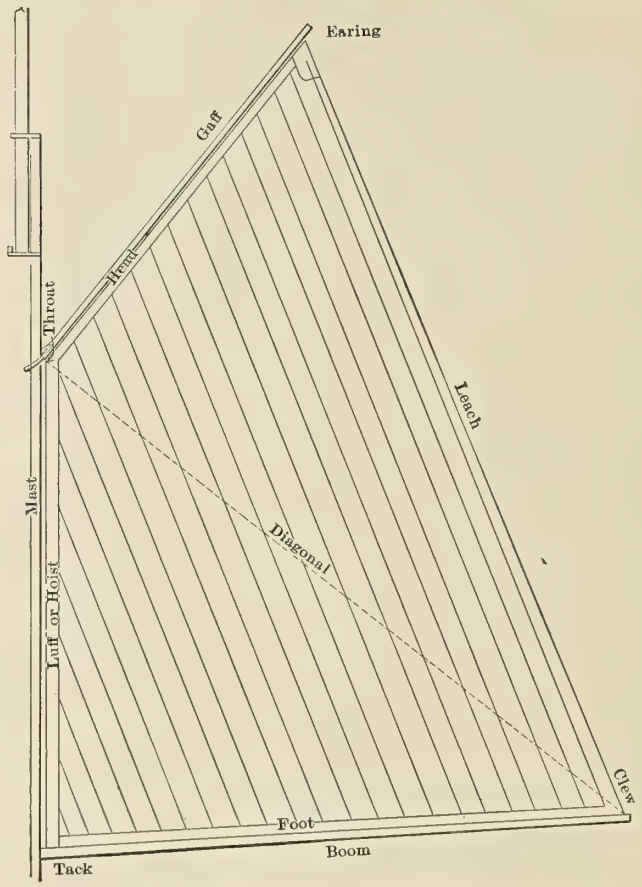


FIG. 3.—SHOWS OLD ARRANGEMENT OF CLOTHS.

as a gore or the diagonal side of the cloth. As the stretch in a cloth is so much greater in its length or warp, of course

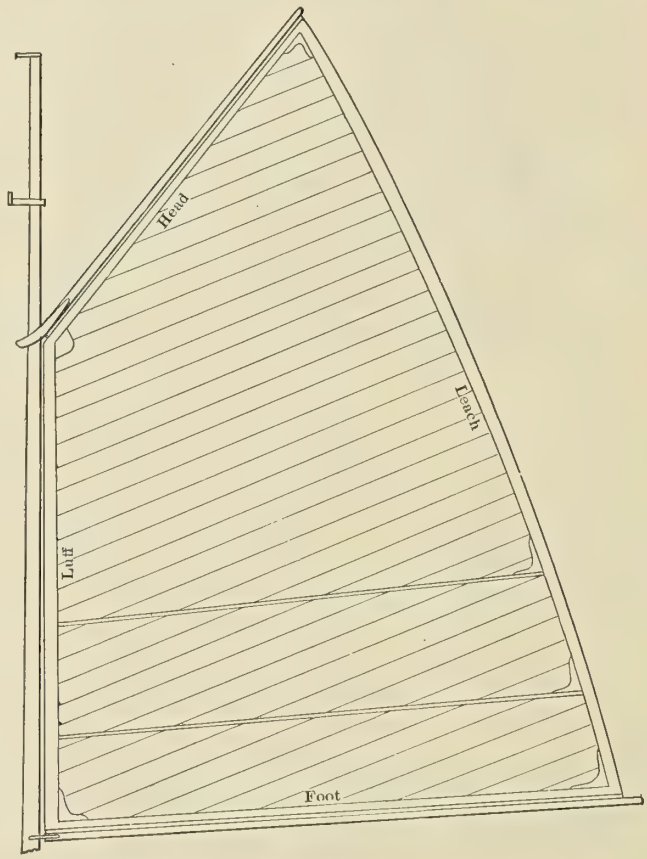


FIG. 4.—CLOTHS AT RIGHT ANGLE TO LEACH, AND CROSS CUT.

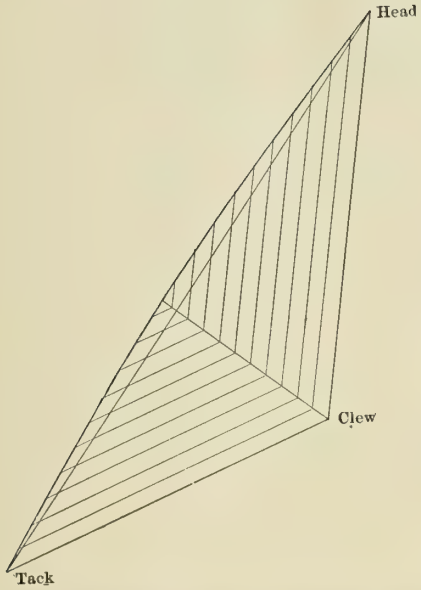


FIG. 5.—CLOTHS PARALLEL TO LEACH AND FOOT.

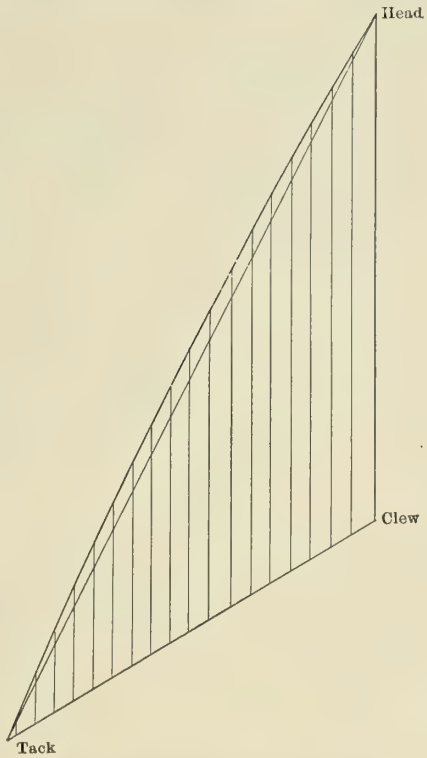


FIG. 6.—CLOTHS PARALLEL TO LEACH.

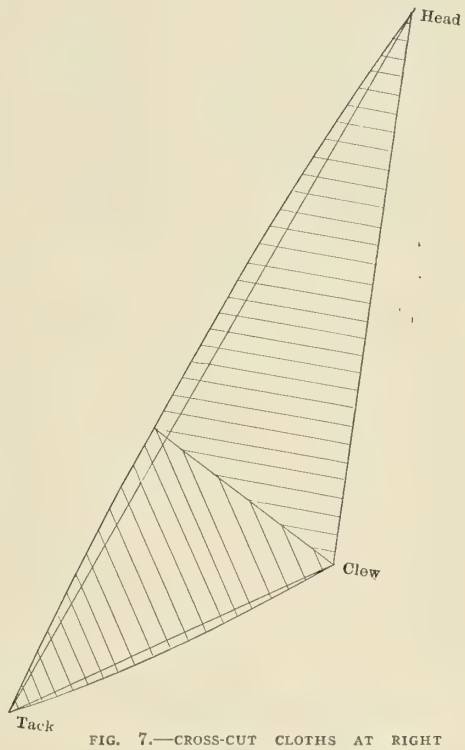


FIG. 7.—CROSS-CUT CLOTHS AT RIGHT ANGLES TO LEACH AND FOOT.

the nearer this gore comes to line of warp the greater the stretch. This unquestionably occurs to a greater degree in a headsail cut with cloths arranged parallel to the leach. With the filling or weft thread arranged so as to be parallel to leach of sail, this gore of the cloth is greatly shortened, and as a result we have only a small amount of stretch to contend with, as can be readily seen by Fig. 11. *A-B* will show the length of gore with cloth parallel with leach of sail; *C-D* will show the length of gore with cloth at right angle to leach; and the same applies to the diagonal of the sail.

While this idea of arranging the cloths may seem new, it is not so, for as far back as 1836 to 1840 it was customary to cut headsails with cloths arranged across the sail, instead of perpendicularly. Why it came into disuse we do not know, except for the fact that these sails are not so strong, and will not wear as long; and at that time, and later, the majority of sails were made for working craft and not for yachts. The famous sloop *Maria* had sails made with crosscut arrangement of cloths. A large part of our work to-day goes to the amateur yachtsman, and, as the crosscut arrangement of cloths means less stretch, the problem of working out the sail is that much simplified, to the great benefit of the yachtsman. I trust that I have given an idea of why we have so universally adopted the crosscut arrangement of seams.

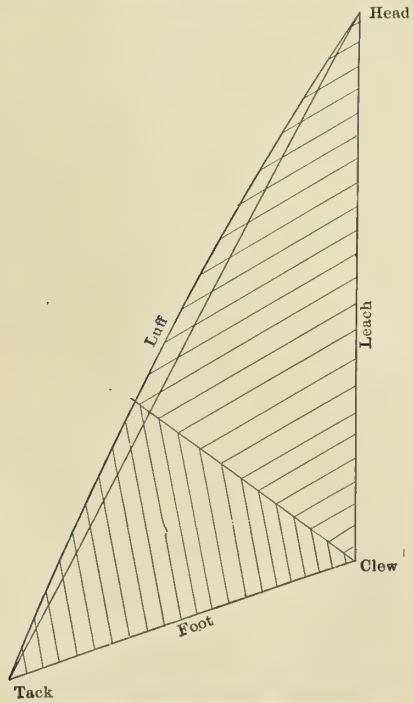


FIG. 8.—CLOTHS DIAGONAL IN LEACH; SQUARE IN FOOT.

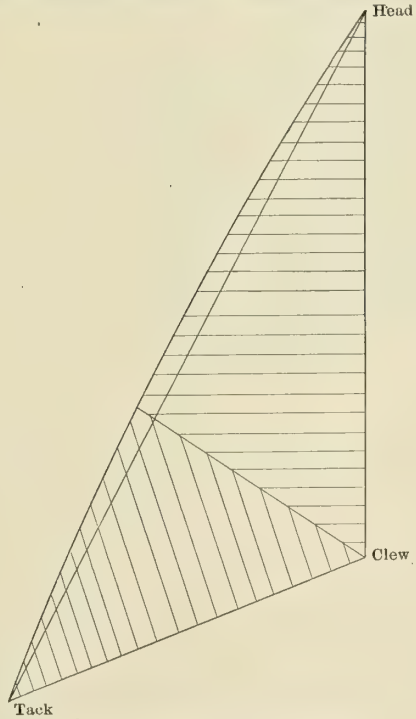


FIG. 9.—A SQUARE AND RIGHT ANGLE ARRANGEMENT OF CLOTHS.

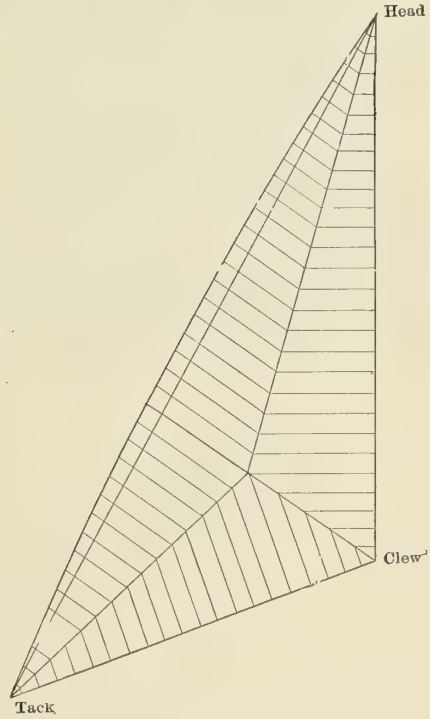


FIG. 10.

In the making of sails with cloths perpendicular to the leach, we established certain rules for working the draft into the body of the sail. Take, as an illustration, Fig. 3, showing a mainsail. We have the sail, with the names of the four sides and corners properly indicated. If it was our intention to make this sail a flat plane, it would appear, at the first glance, that all we had to do would be to cut out on the loft floor a sail whose four sides would be straight lines, sew it together and bind the edges with rope to insure the proper

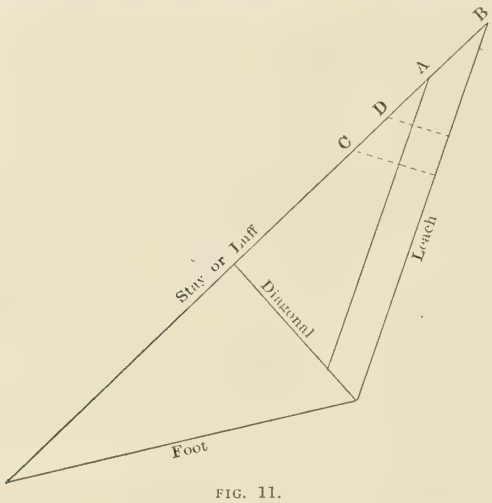


FIG. 11.

A CLASS Q BOAT, WITH MAINSAIL AND BALLOON JIB.

amount of strength. If made in this way it would not stand, as the wind pressing against this surface would produce results which no canvas, no matter of what fiber it was made, would have sufficient strength to stand; and it would tear at the points at which it is attached to the spars.

This is counteracted by certain curves put into the sail, which, when cut and sewed together and spread on the loft floor for the second time, would have the appearance of Fig. 12. The curved lines shown in Fig. 12 would show the sail as cut from the dimensions of Fig. 3, or as would be laid down by the sailmaker. If the sail should be cut with the four sides straight—for instance, if it were cut with the foot a straight line—when the body of the sail filled with wind, the result would be that it would lift up the center of the boom into an arc above a straight line. The tendency of the head to do the same in an opposite direction would result in a light place through the center of the sail. So, we have the curves, or, as known to the sailmaker, the roaches, at the foot of the sail. There is a considerable roach, and it is our object to invert this curved line or part of it into the body of the sail, as shown by dotted line *A-B* in Fig. 12. This we do by tapering the seams in the sail, and it has been the work of years to get this operation to a point that would produce a perfect sail.

A sail made in this manner must be worked out on the yacht when in use by the most careful handling. These sails, which present a surface area of from 450 to 3,000 square feet—and some even larger—are made of a woven material extremely light, when compared with their areas, and are liable to be strained out of their proper shape very easily, by not being intelligently handled. The stress of the weather alone is very severe on them. In hot, dry winds the canvas goes out beyond its normal dimensions, and when wet shrinks inside of the same. So, with what care should a sail be watched? It should not be pulled too hard when dry, and should always be slacked in when wet. If the sail is a good one, under normal conditions it should never be strained out

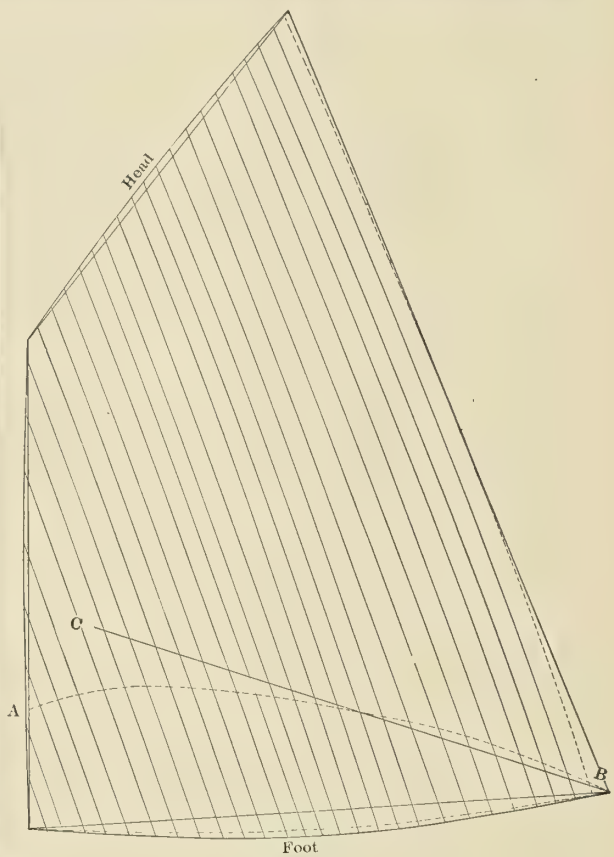


FIG. 12.

so that any undue strain can come on the line marked *B-C*, Fig. 12. This quickly takes all the draft from the body of the sail; and, if allowed to get thoroughly wet, with the clew pulled out too far on boom, the shrinkage on line *B-C* puts an undue tension on the canvas, and the sail becomes hard on this line, and its most important factor—the draft—is rapidly disappearing.

It also tends to hollow the line of the leach, which is always an indication that your sail is losing some of its best points. A new sail should show some considerable outer curve, and, when fully stretched to its dimensions on boom and gaff, should show a true, straight leach. One of the

greatest obstacles the sailmaker has to contend with is the tendency to pull a sail out on boom and gaff as soon as a little slack shows in head and foot rope. The sail may be perfectly dry, and the ropes the same. It will naturally, under these conditions, show some slack at head and foot. This is only on the edge of the sail. Its body is all right. Let it alone. It is doing good work. If pulled out, it gets an undue strain diagonally from end to boom and gaff. It may become damp from the late afternoon dew or from a little fog, when the fullness is immediately taken up.

This constant pulling out on boom and gaff is the cause of throwing the leach into bad shape, as in Fig. 13. The full line *C* is the line of the sail when new. Now, at *A-B* and *A'-B'* the sail does not stretch; in fact, it grows shorter at

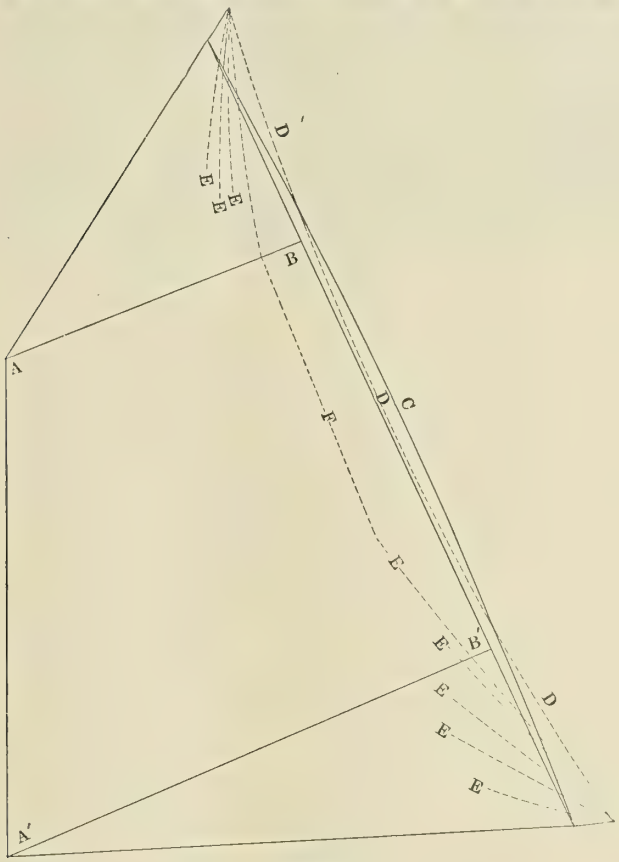


FIG. 13.

these points. If the sail is stretched out so that the leach has become a hollow line like *D*, there is a terrific girt strain in the sail, as indicated by the lines *E*, and the real leach is at about *F*, which will invariably cause a tight place in the sail, from boom to gaff, just forward of *F*. This not only causes trouble at the leach of the sail, but it has pulled all the draft out of the forward body of the sail, and it has become a flat surface from luff aft to a badly setting leach. The greater part of our effort as sailmakers is to construct our sails so as to overcome this very thing. Yachtsmen seem to be possessed with the idea that every bit of slack canvas must be stretched so that the sail is like a drumhead. While this may produce an entirely smooth surface, the very elements that constitute a fast sail may be destroyed. It may produce a picture sail, but not one that has the "go" in it. It would be a very easy matter for us if we had only to make picture sails, but our object is to turn out a sail that will have the "go" in it, and yet be a perfect sail in appearance. As the yacht is a thing of beauty, so the sail must be a part of it.

As before explained, canvas or any other woven material will stretch much more in the diagonal than in any other direction, so it should be an object to relieve the diagonal strain to which the sail is subject as much as possible. As pulling out on boom and gaff tends to increase the diagonal strain, our advice is to avoid it as much as possible.

As a very notable illustration of what can be accomplished in a racing sail, if the sailmaker's instructions are followed and sail not pulled out on boom and gaff as soon as a little slack shows, we cite the instance of the 22-footer *Tyro*, owned by William H. Joyce, and built to sail in the 22-foot class, Massachusetts Yacht Racing Association. The sails made for this boat were cut on the understanding that they should be finished to exact limit of sail plant; no allowances were made for stretch. The boat in all of the races was sailed by the late Sumner H. Foster. Particular care was taken by both Mr.

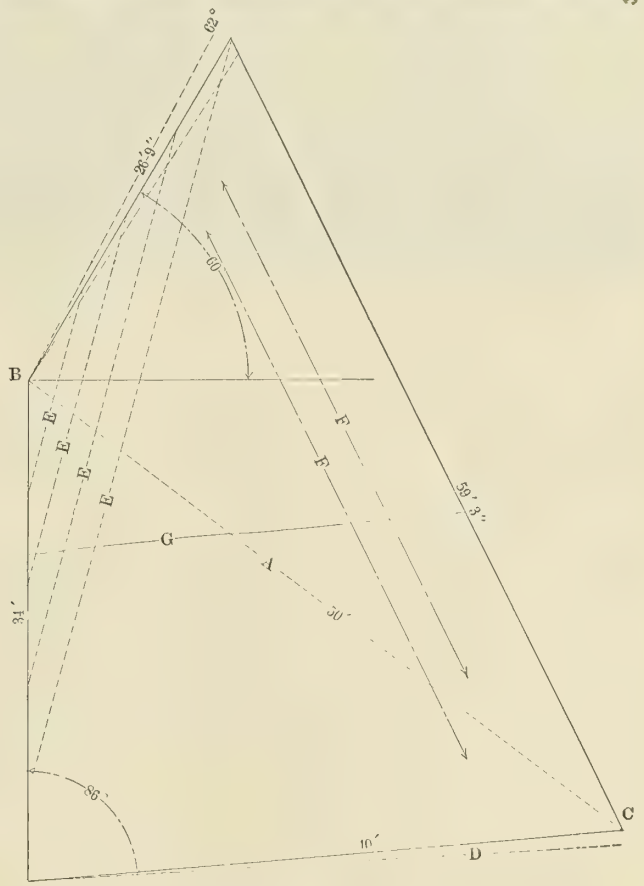
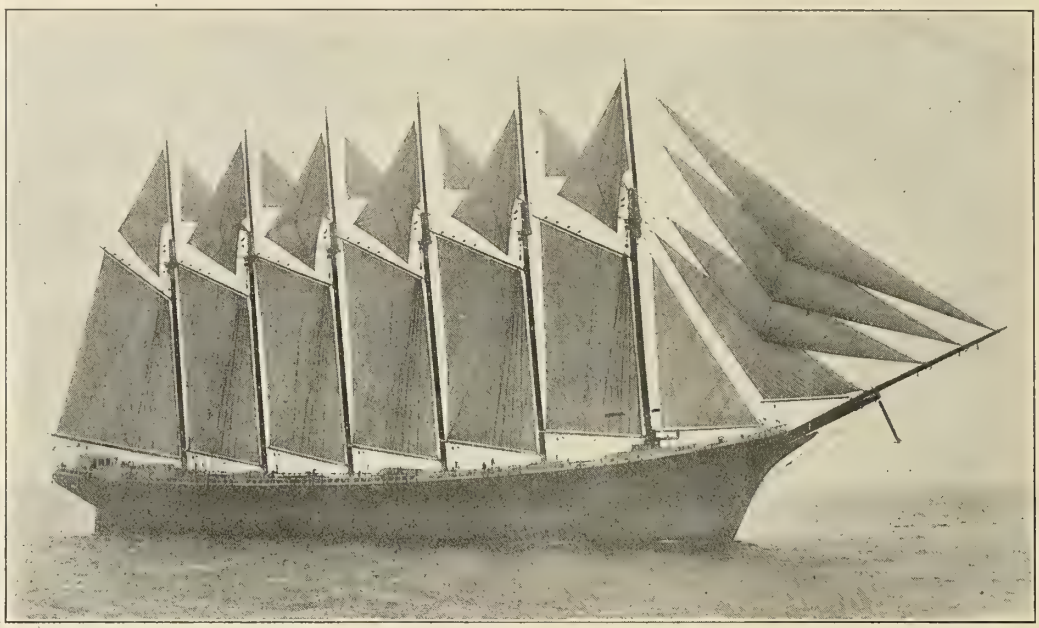


FIG. 14.

Foster and Mr. Joyce that the sail should not be pulled out. It was raced for two entire seasons, and the only change made in the sail was finally in the second season to shorten on gaff about 3 inches, with the result that the original draft, which was put into the sail when new, remained. The sail did the wonderful feat of assisting the boat to win the championship in this class in the Massachusetts Yacht Racing Association for two seasons in succession.

The same advice applies to setting the sail and keeping it properly set while in use. If the sail is not properly set at first, it cannot show to its best advantage. One grievous fault is that of not setting the peak up to its proper angle. In these days of steel halyards there is no excuse for not having a sail set right at the start. In our experience, we have had many complaints of a sail having a bad leach, or the complaint would be that the leach was tight. On investigation, the fault would be found in the fact that the sail had never been set to the angle at which it had been cut. In many instances of this kind the complaint would often be that the boom was too low. In investigating the complaint, the sail would be set under personal inspection, and there would be no tight leach, and the boom would swing at its proper height.

INDEPENDENCE, BRACED SHARP ON THE WIND.



THE SIX-MASTED SCHOONER MERTIE B. CROWLEY, SHOWING ARRANGEMENT OF TWENTY-TWO FORE-AND-AFT SAILS. PHOTOGRAPHS, N. L. STEBBINS.

Let us glance at Fig. 14, illustrating a mainsail on which the peak angle is 60 degrees. Suppose, in hoisting this sail, that it has been hoisted until the luff measures 34 feet, and it is pulled out on head and foot to 26 feet 9 inches and 40 feet, respectively. If, in setting up the peak, it should be hoisted until the sail is perfectly smooth and shows no wrinkles—say to its cut angle of 60 degrees—the result would be that after a half-hour's sailing the give of the halyards and slip caused from the belaying of same on cleat or pin would cause the sail to settle down; also, the give of the canvas would have to be accounted for. The sail would assume the shape indicated by the dotted lines, and an undue strain would take place through the line *A* from *B* to *C*, causing the boom to drop down to dotted line *D*. The sail, if cut at 60 degrees peak angle, should have been set at 62 degrees, or enough to allow for the settling of the peak. A great many yachtsmen think that a mainsail should be hoisted until it is perfectly smooth. I trust you can now see that it should be set above that point in reality. When first hoisted it should show some considerable body of wrinkles under the jaws of the gaff, as indicated by lines *E*.

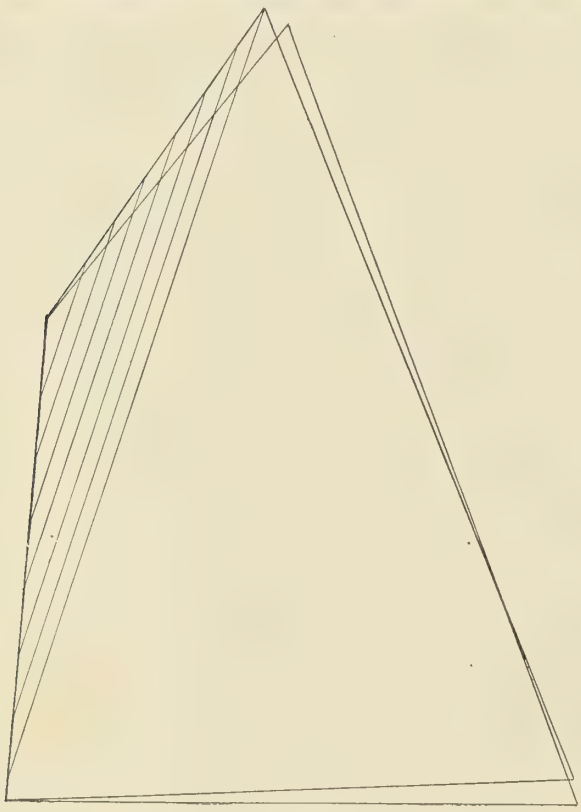


FIG. 15.

The fact that the end of the gaff has settled down below the designed angle, and at the same time the boom has also dropped to a point below plan, causes an undue strain on the canvas below line *B* to *C*. That is, the forward triangle of the sail has to take the whole weight of the sail, and instead of showing its true shape of a curve in forward body of sail, is thereby stretched until it is as flat as a board. Above *B-C* the sail is also in bad shape. It is more than likely that the sail is showing a hard place in the after body, extending about as indicated at lines *F-F*, and at the same time the leach has a tendency to be tight. In fact, the surface of the sail would look something like line *G*. This is somewhat exaggerated, but will convey the idea of the effect on the sail, or what happens when the peak is not properly set.

So, here are two distinct reasons for what may seem to be a tight leach: (1) Over-pulling sail on boom and gaff; and (2) not setting the peak to its proper angle. We have never known a case of a sail being spoiled by over-setting the peak, but have occasion very often to caution our customers to be sure the peak is well set up. When first set, the sail should show plenty of fullness in luff. The peak should be set until the sail wrinkles from gaff to luff (Fig. 15). This may look exaggerated, and may look to the yachtsman as if he were getting his peak up so much as to throw his sail all out of shape; but after the yacht is under way a short time it will be seen that the sail has come to its proper form, and is doing its best work. By setting the sail in this way it is sure to show a perfect leach, free enough to just tremble a little, but not so free as to slap or roll. Also, when sail is reefed, great care should be taken not to pull the reef ear-ring or reef cringle out too far on boom, for in doing this (that is, pulling reef too far out) it acts just the same as pulling foot too hard. These are some of the little details so necessary to know and so valuable, if followed, so that a good sail will always remain a good sail, and a poor sail be worked out into a fairly good one.

(*To be Concluded.*)

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

THE THERMOTANK SYSTEM.

An apparatus that is now very much in use on board the leading great liners and others is that developed by the Thermotank Ventilating Company, of Glasgow, in which the ventilating and heating or cooling arrangements are united in one, as shown in Figs. 55 to 60. The apparatus is arranged either to force air down below under pressure or to exhaust it, the same apparatus being available for either, as may be required. It consists of a tank or cylinder, in which a certain number of tubes are arranged in a vertical position, the air to be warmed or cooled being drawn through them by means of a fan attached to and forming part of the plant. For heating

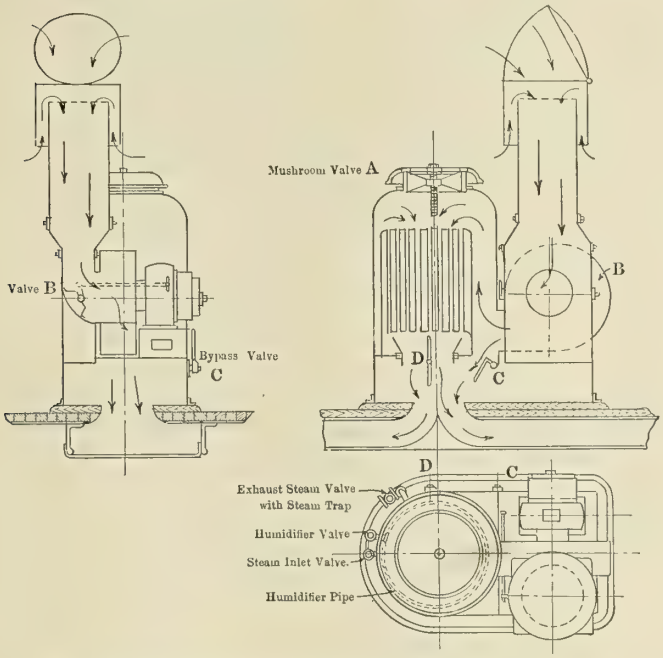


FIG. 55.—TOP-SUCTION DECK-TYPE THERMOTANK SUPPLYING AIR.

purposes, steam is allowed to circulate around the tubes, a supply being brought for the purpose from the nearest steam service. For cooling the air, cold water or cold brine, according to the lowering of temperature required, is circulated. In addition a steam jet is arranged to provide moisture in very dry climates.

There are three forms of thermotank apparatus, which are known respectively as "top suction," "bottom suction" and "between decks." The top suction type, which is shown very clearly in Figs. 55 and 56, is taken from one fixed on the boat deck of the *Lusitania,* and has the cylindrical tank, common to all of the apparatus, in which the pipes are fixed. It has also the mushroom valve that will be seen above the cylindrical tank, and that is marked in the diagrams, and also a protected cowl connected to the fan chamber for the admission of fresh air.

When the apparatus is used to force air down into the staterooms, etc., the mushroom valve on top of the tank is closed, and the air passes from the hooded cowl through the fan up at the back of the pipes, down through the pipes, and thence into the ducts leading to the rooms to be warmed. When the apparatus is to be used for exhausting, the mushroom valve on top of the tank is opened, and the valves marked *D* and *C* at the base of the tank are closed. The air then, instead of being drawn from the hooded cowl, is drawn from below, and in place of passing through the tubes passes up by the side of

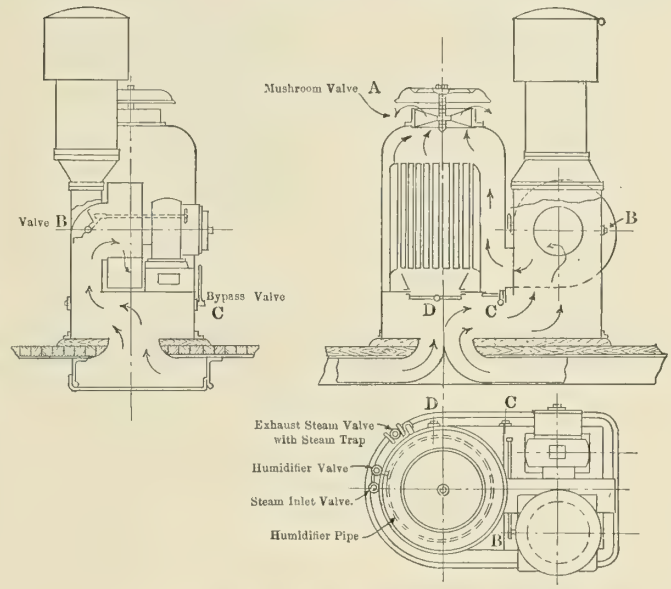


FIG. 56.—TOP-SUCTION DECK-TYPE THERMOTANK EXHAUSTING AIR.

them and through the mushroom valve at the top to the atmosphere.

The bottom suction apparatus is shown in Figs. 57 and 58. It is very similar to the top suction apparatus, the difference being the absence of the hooded cowl described above. In the bottom suction apparatus air is taken from below the fan, as seen in the diagram; is passed through the fan, and thence through the air tubes and down into the ducts leading to the rooms to be warmed or cooled. When the bottom suction apparatus is to be employed for exhausting, the mushroom valve above the tank is again opened, the valves *C* and *D* are again closed, and the valve *B,* which is shown in the diagram, in the suction duct leading to the fan, is also closed, the air from below then passing up through the fan, thence by the side of the air pipes and out through the mushroom valve at the top.

Figs. 59 and 60 show a between-deck apparatus. This is very similar to those described above, the difference being that it is fixed between decks, and takes its air from a duct or flue leading to any convenient supply of fresh air. It is used either for exhausting or forcing air down, just as the others are.

In all forms of the apparatus there is a steam pipe leading to the top of the tank, and an exhaust steam valve and steam trap at the bottom. A perforated steam pipe, surrounding the air tubes, provides the moisture when required. It has the

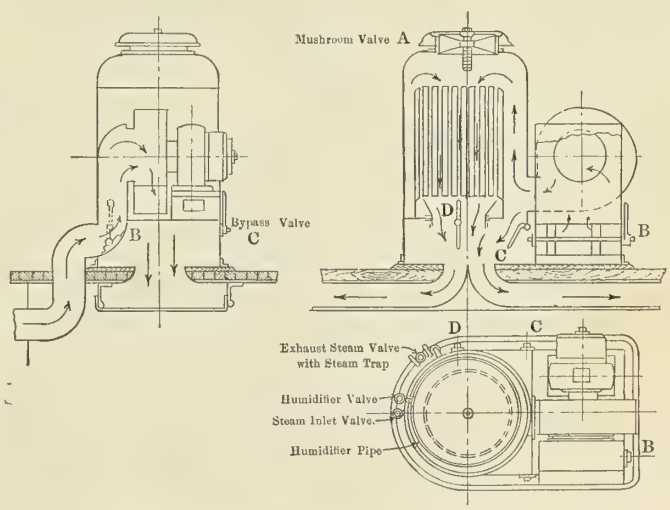


FIG. 57.—BOTTOM-SUCTION DECK-TYPE THERMOTANK SUPPLYING AIR.

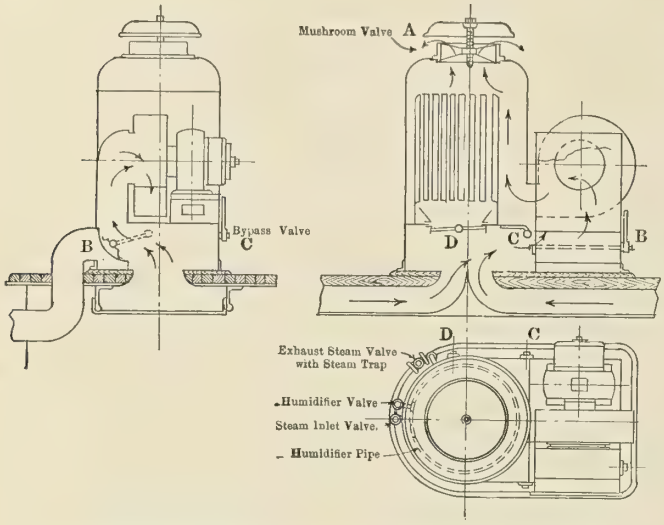


FIG. 58.—BOTTOM-SUCTION DECK-TYPE THERMOTANK EXHAUSTING AIR.

usual valves. For cooling, water or cooled brine, as explained, take the place of steam.

It will be seen, from the description, that the thermotank apparatus practically does for the compartments of a ship what the shafts and fans do for a coal mine. The thermotank apparatus appears also to have been more thoroughly worked out than the system of mine ventilation has, up to the present. It will be noticed that, providing that thermotank and ducts, etc., are provided for each compartment, the engineer has complete control of the ventilation, and the heating, warming and cooling of each individual part of the ship. It will be noticed also that any type of the thermotank apparatus can be used either to force air into the spaces to be warmed, or cooled and ventilated, or can be arranged to exhaust the air from them. This follows the practice adopted in ships which carry cold storage for fruit, in which the temperature is not required to be very low. As has been explained under "Cold Storage on Board Ship," in temperate latitudes the "freezer" engineer works the cold store upon the atmosphere. That is to say, he merely takes the air direct from the atmosphere, passes it through the store and forces it out again. In many latitudes it will evidently be more convenient, and more economical, to adopt this plan with the ventilating air current for shipboard use.

Another point that should be mentioned in connection with the thermotank apparatus, as will be seen from some of the

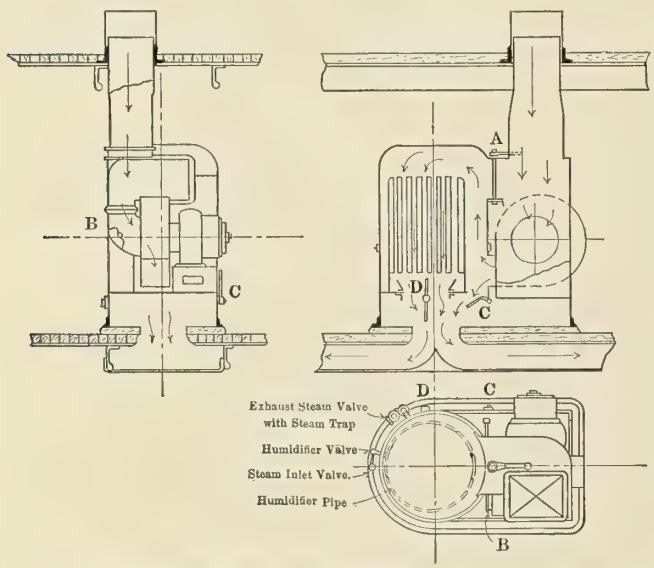


FIG. 59.—'TWEEN DECK TYPE THERMOTANK SUPPLYING AIR.

illustrations, is that it is arranged to regulate the speed of the motor, and with it the quantity of air passing into, or being sucked out of, the spaces operated upon. The regulating apparatus consists simply of an electrical rheostat, arranged to vary the current in the field coils of the electric motor, and thereby to vary its speed. It will be seen that this gives the engineer a more complete control than is possible with any other method, providing that the steps of the regulator can be arranged sufficiently close together. As mentioned, how-

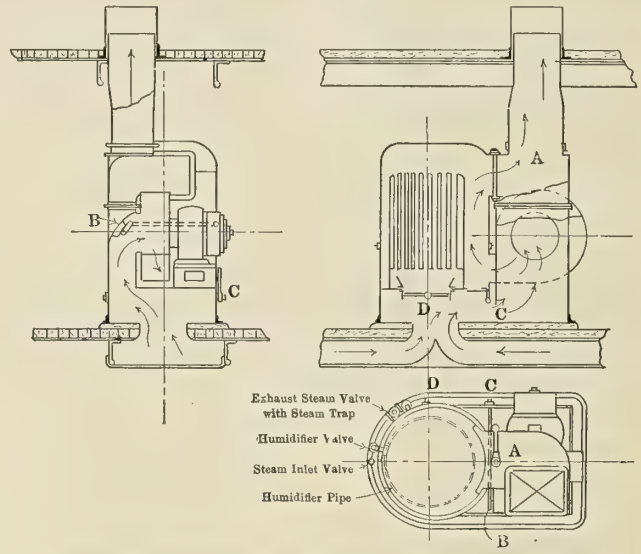


FIG. 60.—'TWEEN DECK TYPE THERMOTANK EXHAUSTING AIR.

ever, in a previous section, the ventilating air current increases very rapidly with the speed, because the volume of air is increased with the speed, and the pressure driving the air is also increased. It is necessary, therefore, that any regulating apparatus should be arranged very finely, so that the changes in the strength of the ventilating air current can be made very small indeed, and the changes in the atmosphere of the rooms under control made very gradually.

It is claimed by the Thermotank Company that its system is very much more efficient than any system of steam-pipe radiation, with exhaust ventilation, and as a proof of this claim are given the curves shown in Fig. 61, in which the time occupied in heating up the air of two Russian ships, one by steam and the other by thermotank, is given. In the figure, the time

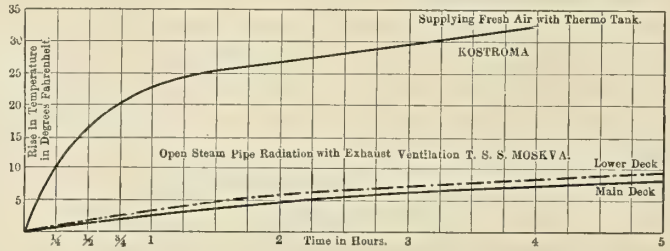


FIG. 61.—THERMOTANK HEATING COMPARED WITH OPEN STEAM PIPES.

in hours is plotted on the base line, as abscissæ, and the rise of temperature is measured by the vertical distances above the base line, as ordinates.

As will be seen, with the thermotank, heating commenced immediately. In a quarter of an hour the temperature had risen about 11 degrees F.; in half an hour it had risen 17 degrees F.; in one hour 22½ degrees F.; and it continued to rise up to 32½ degrees F. at the end of four hours. With the steam-pipe heating, the temperature rises only about 1 degree in a quarter of an hour; 2 degrees in half an hour; 5 degrees in one hour and two-thirds on the lower deck, and

a little over two hours on the main deck; the total rise in five hours being only 9 degrees on the lower deck, and about 8 degrees on the main deck.

These results are very striking, but though every credit should be given to the Thermotank Company for the way in which the apparatus has been worked out, the test in question by no means shows that an equal result might not have been obtained by the aid of steam, or by electricity, if the steam or electrical heating apparatus had been as suitably and carefully arranged as the thermotank apparatus was.

In these tests, the *Kostroma* was fitted with a thermotank supplying fresh air into a compartment of 14,803 cubic feet in extent. The heating surface was 208 square feet. There were 246 persons in the compartment, the air of which was changed 6.9 times per hour. There were 7 cubic feet of air supplied per person per minute.

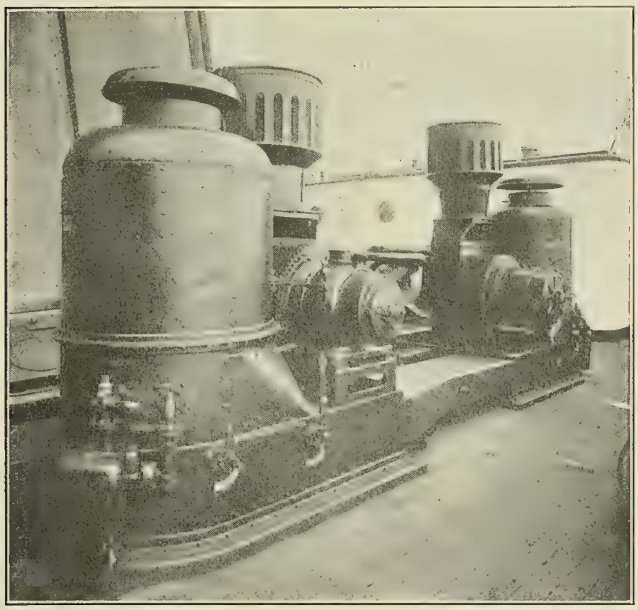


FIG. 62.—TOP-SUCTION DECK-TYPE THERMOTANK FOR FIRST CLASS ACCOMMODATION ON LUSITANIA.

The *Moskva* had open steam pipe radiation, with exhaust ventilation. On the main deck, the compartment in question had a volume of 20,309 cubic feet, contained 262 persons, and was fitted with 202 square feet of heating surface. The air was changed seven times per hour, thus giving each person 9 cubic feet of fresh air per minute. On the lower deck, a compartment of 20,930 cubic feet was heated by a surface of 191 square feet. There were 284 persons, supplied each with 11 cubic feet of air per minute, the air being changed eight and three-quarter times per hour.

THE APPLICATION OF THE THERMOTANK TO THE STEAMSHIP LUSITANIA.

It will perhaps be interesting to describe the application of the thermotank system to one of the latest of the large ocean liners. The whole of the heating and ventilating of the *Lusitania* and *Mauretania* is practically carried out by thermotanks. These are arranged, a large number of them on the boat deck, and a small portion between decks. They deliver through ducts leading to all the spaces to be warmed and ventilated, and through louvre valves into each compartment, the valves being fixed near the ceiling. The warmed air passes in at the higher level, and is carried out by means of other valves near the deck, into the alleyways, etc., from which it is carried off to the atmosphere. In warm weather, when cooling

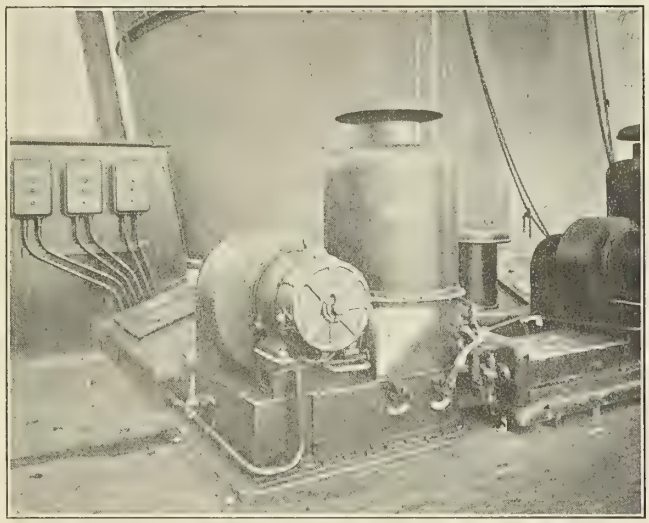


FIG. 63.—BOTTOM-SUCTION DECK-TYPE THERMOTANK FOR FIRST CLASS ACCOMMODATION ON LUSITANIA.

is required, the direction of the air current is reversed by altering the arrangement of the valves in the thermotank apparatus, as explained, and the air is exhausted from the different compartments through the louvre valves, into the ducts, and thence through the thermotanks to the atmosphere.

That portion of the ship allotted to first class passengers has twenty-four thermotanks, principally fixed on the boat deck, around the funnels, and they draw air principally from gratings opening on to the promenade deck shelter, so as to avoid drawing in air that is exhausting from the galleys, etc., on to the boat deck. When the thermotanks are exhausting, the air, of course, passes away, and the question of the odors from galleys, etc., does not arise. It appears to the writer that a certain amount of the injector action that has been mentioned will take place in the thermotank apparatus, when it is being used to exhaust, though the action will be reduced by the special arrangement of the protecting cowl shown.

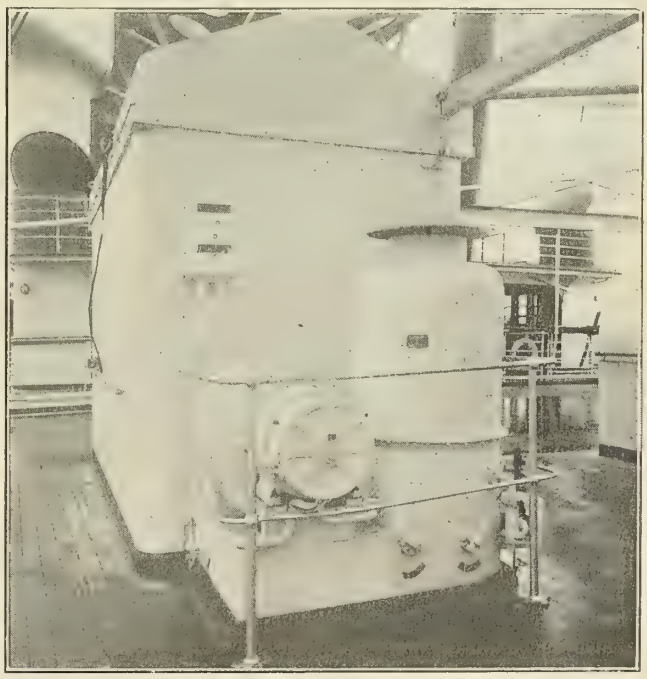


FIG. 64.—BOTTOM-SUCTION DECK-TYPE THERMOTANK FOR SECOND CLASS ACCOMMODATION ON LUSITANIA.

The space devoted to second class passengers has nine thermotanks; the third class, eleven thermotanks; and the officers and crew, five; the thermotanks being arranged on the tops of deck houses and where convenient. Those in the fore end of the ship are placed between decks, and fresh air is obtained for them from the upper deck abaft the navigating bridge, so that, it is claimed, a supply of fresh air is obtained in the worst weather without the exposure of cowl heads, etc., in the forward part of the ship.

The thermotanks are stated to be capable of changing the air in the different compartments up to eight times per hour, and of maintaining a temperature of 65 degrees F. in the coldest weather. The system of thermotanks is inner-connected, so that in case of the breakdown of any individual apparatus a supply can be obtained from one of the others.

The arrangement of inter-connection appears to the writer to be a very good one, though it necessarily somewhat complicates the apparatus. The large number of thermotanks that it

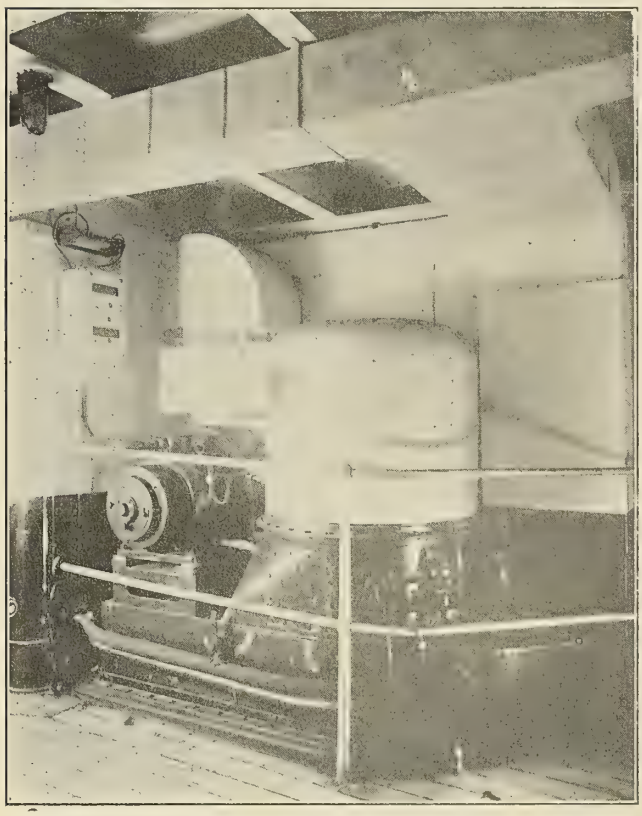


FIG. 65.—'TWEEN DECK TYPE THERMOTANK FOR THIRD-CLASS ACCOMMODATION ON LUSITANIA.

is necessary to employ (forty-nine in all) is also a matter for consideration, as it takes up a great deal of space on the boat deck and elsewhere ,and it adds to the apparatus to look after. On the other hand, the engineering staff of a large liner is thoroughly qualified to look after the apparatus, and, in fact. their labors, with ordinary care, should not be greatly increased by the employment of the apparatus.

In the *Lusitania,* in addition to the thermotanks, twelve powerful exhaust fans are connected by trunks to all the galleys, pantries, bathrooms, lavatories, etc., the fans being of sufficient capacity to change the air at least fifteen times an hour. The holds and other compartments, forward and aft, are also mechanically ventilated, so that the provision mentioned above of the air from the compartments finding its way to the alleyways, etc., and thence to the atmosphere, is easily arranged, and the whole system of ventilation and of heating and cooling the different compartments of the ship appears to be exceedingly well provided for.

One serious objection arises from the fact that it has been necessary frequently to supply both inside and outside staterooms from the same thermotank. The heat generated in the interior of these ships by the immense boiler plants, and dissipated and radiated, to a large degree, by both the main turbines and the numerous auxiliary engines, keeps the inside of the ship at a relatively high temperature; with the result that of two rooms, side by side, one being against the side of the ship and the other inside, there will be, particularly in winter weather, a difference of temperature amounting in some cases to as much as 10 degrees F., and occasionally much more. If, now, the same heat be supplied to each, the inner room will become insufferably hot before the outer gets comfortable. In such a case as this some auxiliary method of regulation becomes well-nigh imperative; and it is reported that this will be supplied by fitting small electric heaters to the outside rooms, and allowing these to make up any difference necessary between a comfortable temperature in the inside rooms and the corresponding temperature in those next the skin of the ship. Automatic regulation of these heaters should be provided, so as to minimize the consumption of current and conduce to the largest comfort of the passenger.

(*To be Continued.*)

A CLYDE-BUILT TURBINE YACHT FOR AMERICA.

BY BENJAMIN TAYLOR.

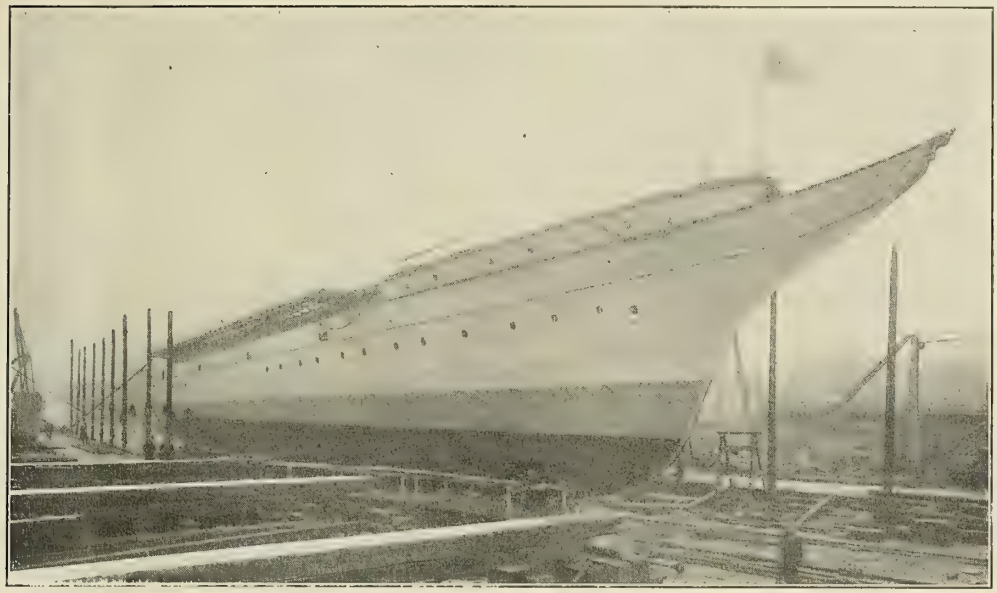
The steam yacht *Vanadis* has been built for C. K. G. Billings, of the New York Yacht Club, from the designs of Tams, Lemoine & Crane, of New York, by A. & J. Inglis, Glasgow. She will be one of the most prominent additions to the yachting fleet of America in 1908, and she is the first yacht of large size to be constructed abroad from American designs for American owners. She was launched Jan. 23, 1908.

Her dimensions are: Length over all, 277 feet 6 inches; length on waterline, 232 feet 7 inches; beam, 32 feet 7 inches, and depth, 19 feet 1 inch. With a draft of 14 feet the displacement is about 1,350 tons. The Thames yacht measurement is 1,230 tons, and the gross register tonnage about 1,075. She is about the same size as Mr. Vanderbilt's steam yacht *Warrior,* designed by G. L. Watson & Company, of Glasgow; but, with practically the same boiler power, the *Vanadis* has turbines, while the *Warrior* has reciprocating engines.

The *Vanadis* is built of steel throughout. She has eight watertight bulkheads and a double bottom, and will be practicably unsinkable in case of collision. She is classed 100 A1 at Lloyd's under special survey. Her bunkers hold sufficient coal to enable her to cross the Atlantic from Southampton to New York at a reasonable speed; at normal (trial) displacement she carries 135 tons. Her cold storage rooms will hold sufficient fresh provisions to feed all hands during three months. She is designed for general cruising, the designed speed being 15½ knots.

The vessel is high-sided, and has a long steel deck house amidships on the main deck, with shade deck extending the whole length of the house, and a topgallant forecastle. She is schooner rigged, with two pole masts and a large smokestack. To minimize rolling, narrow bilge keels are fitted over a portion of the length.

The owner's and guests' quarters are both forward and aft of the machinery space; the servants' and stewards' quarters are in the extreme afterpart of the vessel, and the officers and crew are forward. There is a servants' portion, with its own messroom, for the servants of the owner and guests. The owner's private rooms are at the after end of the main deckhouse. They consist of a suite of two large bedrooms (12 by



VIEW FROM THE STARBOARD BOW, SHOWING THE GREAT OVERHANG OF THE CLIPPER STEM.

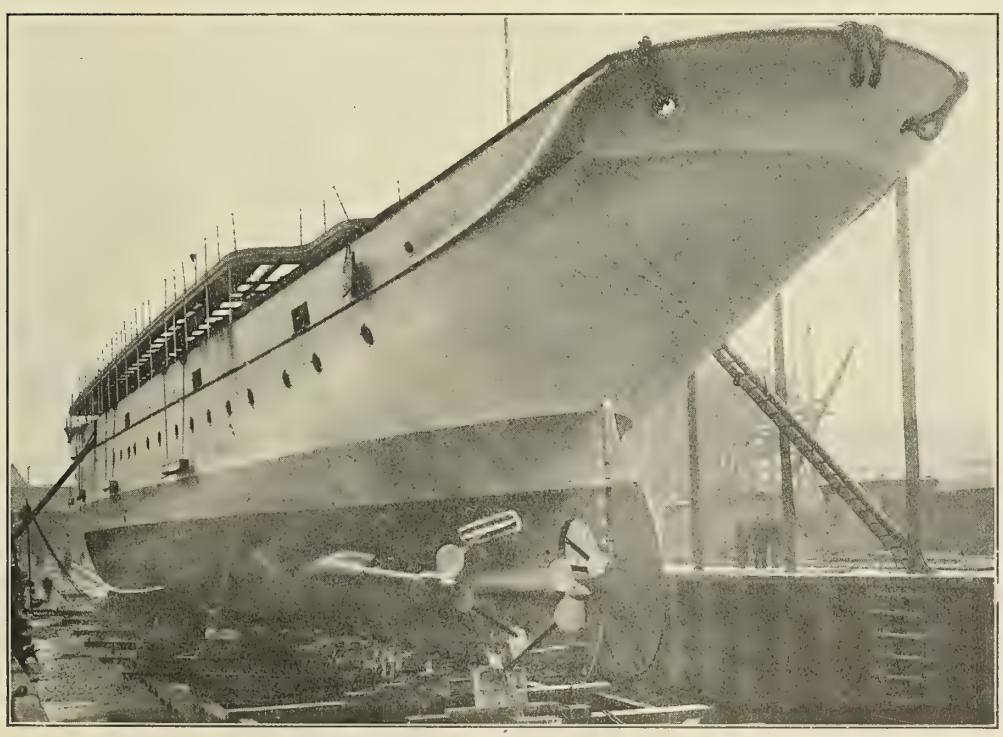
14½ feet, and 13 by 13½ feet) and two large bathrooms, with commodious wardrobe closets. The guests' quarters consist of eight staterooms and six bathrooms, arranged in suites.

In the deckhouse, forward of the owner's quarters, is a large vestibule, finished in English oak, and forward of this is a drawing room in white enamel (14 by 18½ feet), with an open fireplace at one end. From the drawing room a passage leads forward to a large dining room in oak, 22 feet long by 18 feet wide. In the deckhouse, between the dining room and drawing room, are the crew's galley, captain's stateroom, owner's galley and a large pantry. From this passageway a stairway leads to a large smoking room (11¼ by 16 feet) on the shade deck, and a chart room just aft of the smoking room.

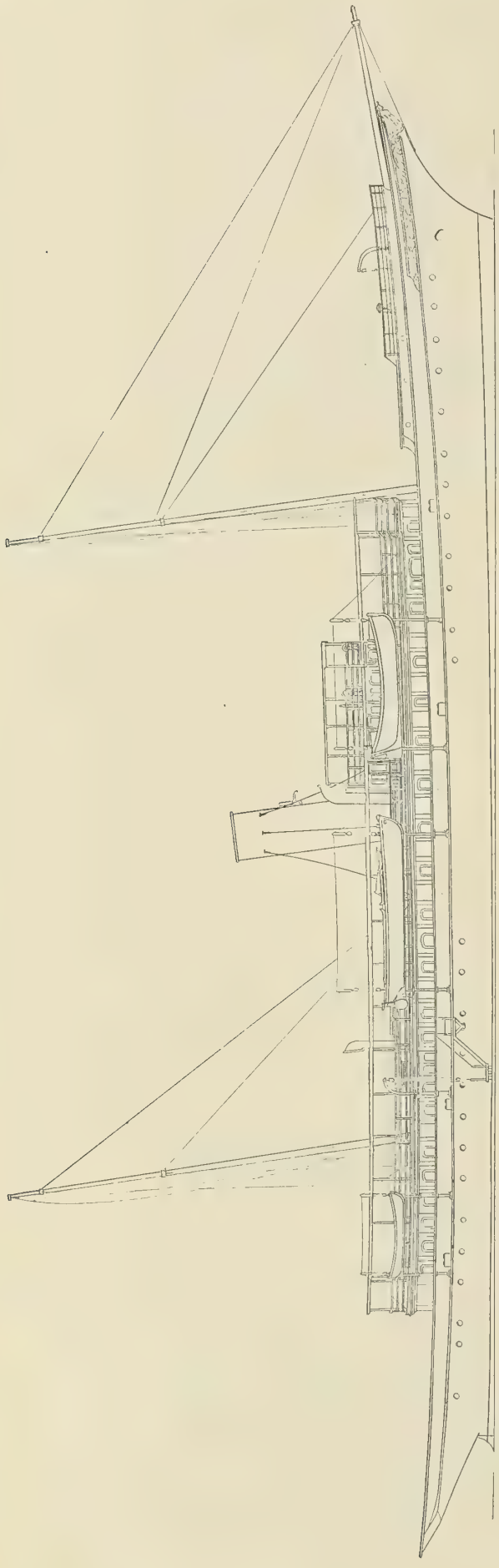
Ventilation has been carefully considered. In addition to a skylight for each room and port lights there is a forced system of ventilation which delivers air through ducts by means of a blower of sufficient capacity to change all the air in the vessel every ten minutes. She is heated throughout by steam.

The *Vanadis* has a shade deck amidships, and a raised forecastle, in which are quartered some of the officers, and where also are commodious store rooms. An electric elevator runs from the pantry to the store rooms. Provision has been made for carrying a large motor car on the forward deck, with arrangements for lifting the machine from the shore on to the boat.

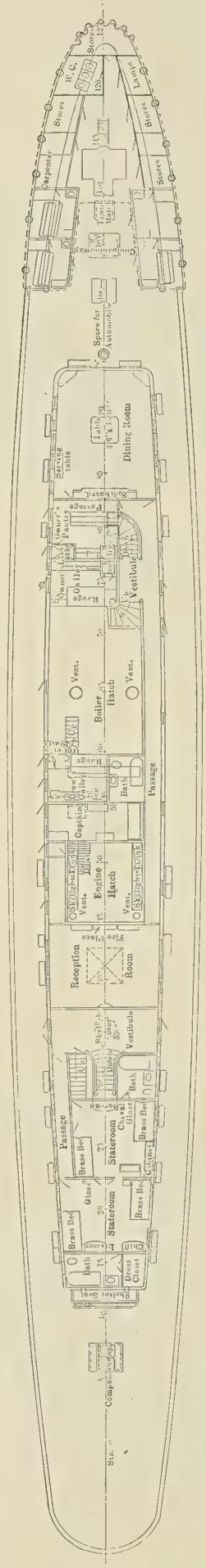
The propelling machinery consists of three Parsons turbines of a combined capacity of 3,000 horsepower, driving three bronze propellers. Steam is supplied from two single-ended Scotch boilers, 16 feet in diameter and 11 feet 9 inches long. Each boiler has four Morison suspension furnaces. The steam pressure is 155 pounds per square inch. Forced draft is provided for by two 25-inch Sirocco fans, direct connected to

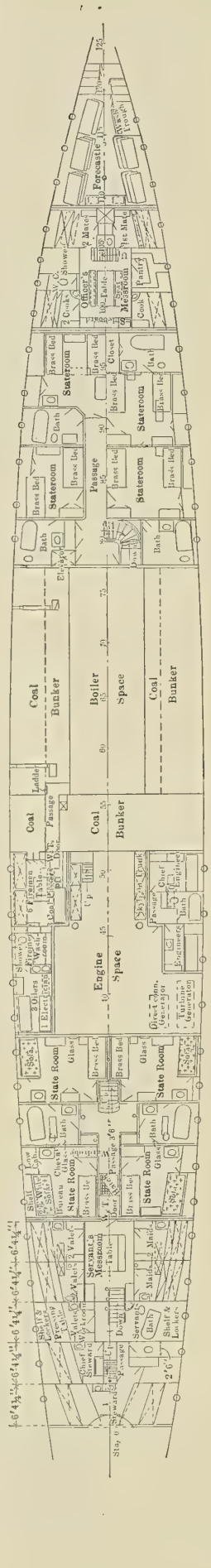


STERN VIEW OF THE NEW TURBINE-PROPELLED STEAM YACHT VANADIS, BEFORE LAUNCHING.



THE OUTBOARD PROFILE SHOWS EASY LINES AND GRACEFUL APPEARANCE, WITH GOOD FREEBOARD AND AMPLE RESERVE BUOYANCY.




Forecastle
Crew's Toilet
Officer's Mess
Officer's Pantry
Officer's Toilet
Stateroom
Brass Bed
Bath
Passage
Coal Bunker
Boiler Space
Engine Space
Coal Passage
Ladder
Electric Motors
Electric Generator
Engineers
Engineers' Toilet
State Room
Glass
Brass Bed
Bath
Sofa
Table
Mail
Shelf & Lockers
Steward's Pantry
Steward's Toilet
Steward's Stateroom
Steward's Passage
Steward's Mess Room
Steward's Table
Steward's Bath
Steward's Shelf & Lockers
Steward's Sofa
Steward's Mail

electric motors, each operating at 825 revolutions per minute.

The design has been of attaining all possible economy at low speeds—the weak point of former turbine yachts having been the excessive coal consumption at the lower speeds. In carrying out this design the builders have had to use longer turbines than have been before built for such a low power. These turbines are arranged in the usual method—a high-pressure turbine on the center shaft and two low-pressure turbines on the wing shafts, each turbine driving its individual propeller. The wing shafts carry reversing turbines, which are capable of developing 60 percent of the full power. The engineers and firemen are quartered in the space directly adjoining the engine and boiler room.

There are two surface condensers. Included in the auxiliaries are two Edwards air pumps, two centrifugal circulating pumps, two vertical simplex feed pumps, and two General Electric generators. The latter are of 15 and 25 kilowatts capacity, respectively, one being (Curtis) turbine-driven.

The *Vanadis* carries six boats. Two 35-foot motor launches for the owner are driven each by a 75-horsepower Simplex engine. One of the launches is commodious and has a speed of 12 knots; the other is narrower, and has a speed of 22 miles. There is a crew's launch, 26 feet long, driven by a naphtha engine, and there are two 26-foot lifeboats and a 16-foot dinghy.

THE NEW STEAM YACHT LIBERTY BEING FITTED OUT IN THE LEITH DOCKS, ALONGSIDE SEVERAL SAILING VESSELS.

THE TWIN SCREW STEAM YACHT LIBERTY.

BY BENJAMIN TAYLOR.

This fine steam yacht of 1,580 tons, Thames yacht measurement, has been built by Ramage & Ferguson, Ltd., Leith, for Joseph Pulitzer, of the *New York World,* from designs by J. R. Barnett, of G. L. Watson & Co., Glasgow. She was launched December 5 last, and is already in service in the Mediterranean. Mr. Pulitzer last year chartered Baron De Forest's 1,000-ton steam yacht *Honor,* which was also built at Leith from Messrs. Watson's designs, and so well was he pleased with that vessel that he commissioned the same designers and builders to do the work for him; and before his charter had expired the new yacht was under way. The *Honor* was taken as a basis, and to outward appearance the new vessel has a strong resemblance to her, but she is larger, and there are many points in which she shows a decided improvement.

The *Liberty* is schooner-rigged, with two pole masts and large smokestack, clipper bow with scroll head, and an elliptical stern. She is practically a three-deck vessel, though there is a short break at the foremast. This, however, is scarcely noticeable to a casual observer. On the top deck she has a long, unbroken range of steel deckhouses amidships, with chart room and flying double bridge above.

The accommodation has been carried out to her owner's ideas, and in this respect is something quite different from other pleasure vessels of her size. The part of the yacht forward of the machinery space is entirely devoted to the owner's private quarters and the store rooms; all the guests' rooms and the servants, officers and crew being aft. This insures entire privacy, in addition to which all the bulkheads have been specially "deafened" to eliminate noises from the engines, etc. To get forward, when necessary, the crew need not come on deck at all, for a special passageway has been arranged on the port side of the lower deck, leading from their quarters aft to the store rooms, etc., forward, and by a stairway they get to the forecastle deck.

In the range of deckhouses on the upper deck, commencing forward is the owner's library and study (15 by 17 feet), with lavatory and private vestibule adjoining; then there is the dining room, a very large apartment (16½ by 23 feet), in oak, from which an oak corridor runs aft on the starboard side to the drawing room (14 by 17 feet) aft of the machinery. On the port side there is a passage leading from the dining room to the main pantry, which is placed between the engine and boiler casings. The drawing room is finished in white, with panels of silk on the walls. A smoking room (12 by 14 feet) in darker oak is placed aft of the drawing room, and at the after end of this room there are double doors, which can be thrown open to a fine deck shelter, forming the after end of

the deckhouses. All these rooms have been specially designed by Murray, of London, and executed by Wylie & Lochhead, Ltd., Glasgow. By substituting for the ordinary lean-to skylights rectangular lights in the lower panels of the house (communicating by trunks to the rooms below), it has been possible to secure an unbroken promenade of over 8 feet in width between the house and the ship's side. These trunks are so arranged as to be covered by the furniture in the deckhouse.

On the main deck, the owner's rooms are forward. These are reached by a stairway from his private vestibule in the deckhouse. There is a large bed room (16 by 22 feet), and also a sitting room (12 by 21 feet), which may be used as a breakfast room, a bath room, etc. The windows of these rooms look out over the break deck, the side walls being kept in from the side of the vessel a few feet, though the deck above extends out to the side. This affords protection while giving ample light and air. The headroom everywhere is exceptional. Below these rooms on the lower deck there is another very large room, bath room, clothes room, etc., and forward of these is a gymnasium, fitted up with the best apparatus for getting exercise at sea. This gymnasium is a large room, and has great height (11 feet), extending right up from the lower deck to the break deck, with large skylight on top. There is a spray bath attached. A passageway on the lower deck, starboard side, allows the guests to enter the gymnasium. The part of the vessel forward of the gymnasium is occupied by the chain lockers, store rooms, a hospital with lavatory attached, lamp room and other offices.

On the main deck, on the starboard side of the engine and boiler casings, are five guests' rooms and a bath room. These are intended for bachelors. Aft of the casings there are six fine large staterooms, the smallest 10 by 11½ feet, and the largest 13 by 13½ feet, with two bath rooms and a boudoir. All these cabins are well lighted and ventilated. On the port side of the casings are servants' rooms, with a large sitting and mess room, cold larder, scullery, etc., and also the captain's room. The main galley is placed between the casings under the pantry.

The crew's quarters are all aft, occupying the whole of the lower deck aft of the machinery and that part of the main deck which is aft of the guests' quarters. There is a large open space on the main deck for the use of the crew, which may at will be closed by watertight shutters. Aft of this are the crew's galley, wash rooms, bath rooms, etc. On the lower deck, the extreme after end is occupied by the firemen. Forward of this the seamen are berthed on the port side, and the officers on the starboard side. In the holds are ample store rooms, those forward being reached by a trunk hatch from deck, as well as by an internal stairway for the steward. The cold rooms for owner and crew are very ample, a powerful refrigerating plant being installed.

The machinery consists of two triple expansion engines, with cylinders 16, 26 and 42 inches in diameter by 24 inches stroke. The propellers are of bronze, and are of different pitch, so as to reduce vibration to a minimum. There are two cylindrical return tube boilers of the Scotch type. These are of different sizes—the large one being ample to supply steam for cruising speeds—the small one suitable for use in port and for short runs at moderate speed. While there is no extravagance, all the latest improvements in auxiliary and deck machinery have been adopted.

There are two large independent electric light engines; a storage battery; a steam windlass on the forecastle deck, and a powerful steam capstan forward of this. The anchors are stockless, stowing in the hawse-pipes. Underneath, on the main deck, is an electric capstan for working a kedge anchor, and there are separate hawse-pipes for this purpose. Aft, on the main deck, is the steam steering engine, controlled from the flying bridge, and there is hand gear on the upper deck, immediately above the steering gear. On the upper deck right aft is a steam warping capstan. In the casings amidships is an electrically-driven boat-hoisting engine, with capstan heads on each side, so that all boats may be easily and rapidly handled. The vessel is heated throughout by hot water.

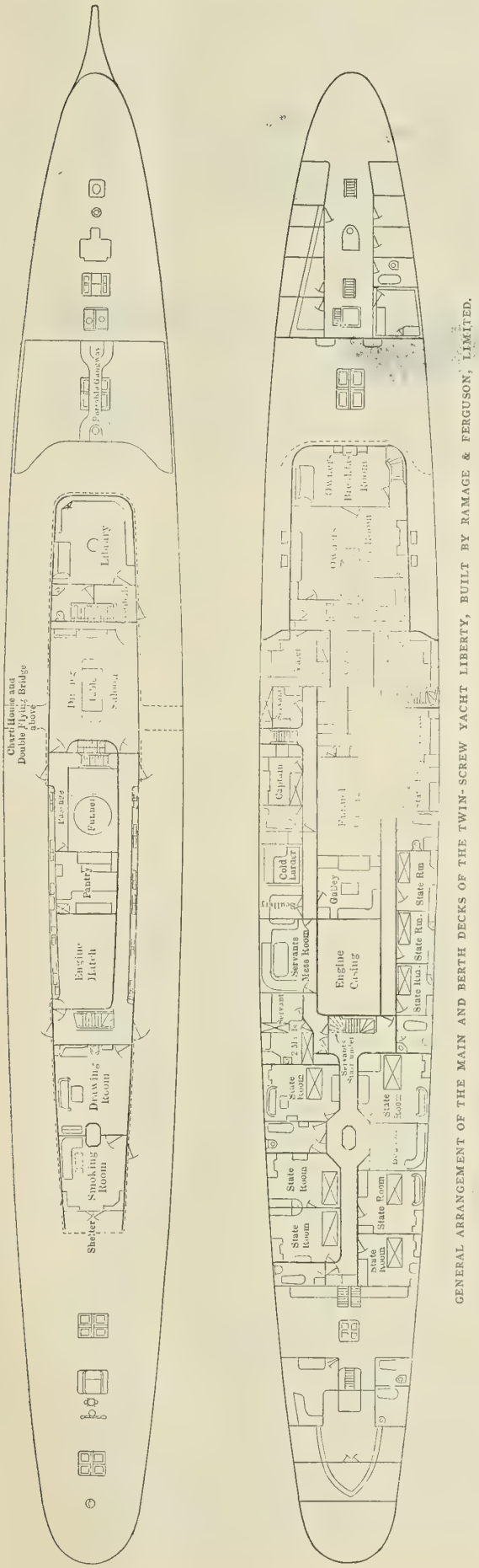
The *Liberty* carries four rowing boats and two steam launches, all berthed on skids above the upper deck, almost like a boat deck. From here the sails for steadying her in a seaway are worked, so that the upper deck is left quite free as a promenade. She is navigated from a flying bridge located above the chart room, which is situated on top of the deckhouse, just forward of the funnel.

The two steam launches were built by Simpson, Strickland & Company, Dartmouth. The larger of the two boats is 32 feet long by 6 feet 6 inches beam, and is built of specially selected mahogany with waterways and coamings. There is a small well forward, then comes the engine space, and immediately aft of this is a steering-well, so that the coxswain is not among the passengers, and yet within easy call. The seating arrangement in the after well is on a somewhat novel plan. The forward thwart is as usual, but the after thwart is specially wide, and carried right out to the sides of the boat, and is not joined by the fore-and-aft benches, so that there is ample and comfortable room for the knees of the passengers using it. At a distance of some 2 feet from this thwart are folding side benches on each side, giving plenty of room for all, while more passengers can sit facing forward than is possible with the ordinary arrangement. Folding hoods are fitted to both fore and after wells. The machinery consists of a triple-expansion engine, with cylinders 3, 4¾ and 7 inches in diameter, by 5½-inch stroke, working at a pressure of 175 pounds per square inch, and giving about 20 indicated horsepower. The speed of this boat on the official trial was found to be 8.67 knots—more than half a knot in excess of the contract.

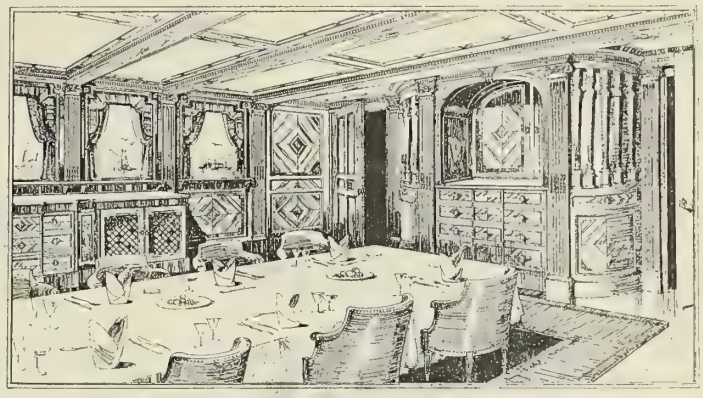
The smaller boat is 26 feet long by 5 feet 8 inches beam, and is of the same general design and construction, but the machinery is interesting, as being a good example of the successful use of oil fuel on the Lune Valley Engineering Company's system. The engine, a Kingdon tandem quadruple, having cylinders 2½, 3½, 4¾ and 6 inches diameter, with 3½-inch stroke, and working at 175 pounds pressure, gives about 10 horsepower. The boiler is a Lune Valley watertube type, using paraffin (kerosene) as fuel. This was found to give ample steam; in fact, throughout the official trials the regulator for the burner had to be slightly closed down, and this was found to give perfect control over the pressure. The speed obtained on trial was just over eight knots—more than a knot in excess of the contract.

On Jan. 31 the *Liberty* went out on her first steam trials in weather anything but pleasant. There was a stiff northwesterly wind blowing all day, approaching a gale in strength, and this afforded an excellent opportunity for testing her behavior at sea. She proved herself an excellent seaboat, easy and comfortable in motion, and the impression formed from an inspection of the vessel before she was launched was confirmed, in that she will also be a dry boat.

On the measured mile at Gullane, where there was a considerable sea, she had a few progressive runs, and a mean speed of 15¼ knots was easily obtained. The boilers gave ample steam, so there was no difficulty in maintaining this speed, which is considerably over the contract guarantee. A five-hours' continuous run was then undertaken at a cruising speed of 12 knots, during which run the auxiliary machinery was put through exhaustive tests, with successful results. During the whole day the machinery gave excellent satisfaction, without any hitch, notwithstanding the fact that this was the first run it had had. One remarkable feature of the day's



GENERAL ARRANGEMENT OF THE MAIN AND BERTH DECKS OF THE TWIN-SCREW YACHT LIBERTY, BUILT BY RAMAGE & FERGUSON, LIMITED.



THE DINING SALOON ON THE LIBERTY.
By courtesy *The Yachting and Boating Monthly.*

trials was an almost total absence of vibration, even at the highest speed.

The yacht has been specially designed for ocean cruising, and promises to be particularly well adapted for that purpose. She has very large bunkers, so that she can carry sufficient coal to allow her to cross the Atlantic and back again without coaling. For the same reason she has very large storage tanks for fresh water, besides having evaporating and distilling apparatus. In several features the designer has had to study utility as the chief object. She has a relatively flat bottom and moderately full ends, quite in contrast to the peg-top sections and hollow ends of earlier yachts. Her length on the waterline is 250 feet, with a beam of 35 feet 6 inches. She is about 300 feet long, over all.

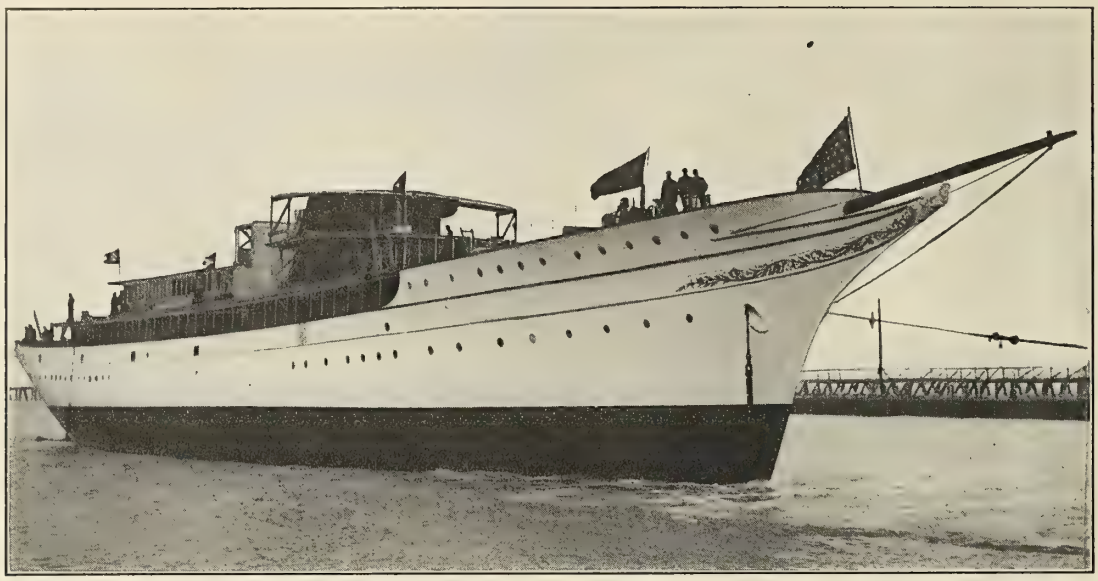
The Twin-Screw Steam Yacht Iolanda.

The steam yacht *Iolanda,* of about 2,000 tons yacht measurement, was built for Commodore Morton F. Plant, of New York, by Ramage & Ferguson, Leith, from designs by Cox &

ONE OF THE UPTAKES FOR THE IOLANDA.

King, London, and under their superintendence. She is the second largest privately-owned yacht in the world. Her principal dimensions are: Length over all, about 305 feet; beam, 37 feet 6 inches; depth, 23 feet; length on the waterline, 258 feet; draft, 16 feet 6 inches. She was launched March 4, 1908. She is built of steel and is schooner rigged.

The twin-screw machinery is of the triple-expansion four-crank type, of about 3,500 collective indicated horsepower. One of the features is that her boilers are partly cylindical marine return tubular and partly watertube. This combination, the first installed in any yacht, affords the special advantage



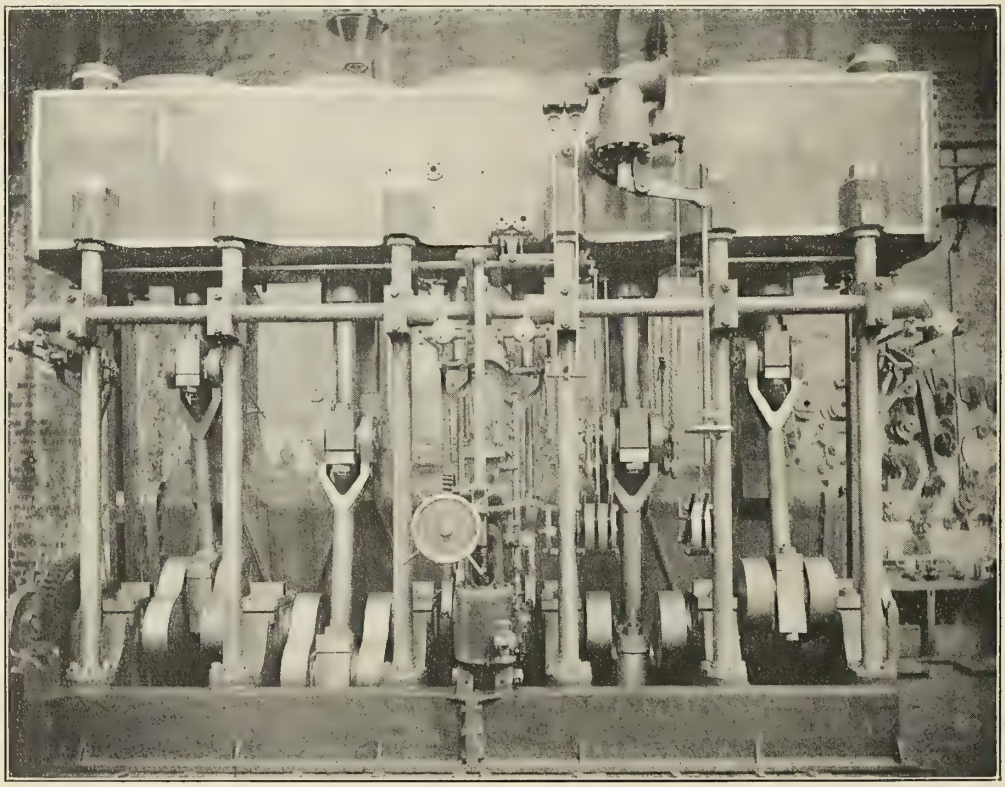
THE NEW STEAM YACHT IOLANDA, JUST AFTER BEING LAUNCHED BY RAMAGE & FERGUSON.

of enabling steam to be raised and the vessel got under way at practically a moment's notice. It also provides additional speed at short notice when required, while the bunker capacity of some 550 tons gives the yacht a very extensive ocean-steaming radius.

There are two inverted direct-acting surface condensing engines, each set having four cylinders, 19, 31, 35 and 35 inches in diameter and 27 inches stroke. The two cylindrical boilers are 17 feet in diameter by 11 feet long, with 321 square feet of grate area and 9,084 square feet heating surface, the ratio being 28.3 to 1. The two watertube boilers were built by the Babcock & Wilcox Company. The one funnel is elliptical in section, with a major axis of 15 feet, and is 55 feet high.

The outfit includes motor and steam launches, quick-firing guns, an elaborate system of electric lighting (the largest ever installed in a private yacht), and an installation of wireless telegraphy. The heating system throughout the yacht is by steam. The refrigerating plant, with cold chambers, etc., has been carefully planned, and has large storage capacity, including fish stores, dairy, etc. A spacious laundry is fitted up on the orlop deck, the laundry machinery being worked by electric motors. A comprehensive system of ventilation is installed, thirty motor-driven centrifugal fans being employed in this service. The electric plant includes three 30-kilowatt generators. The yacht is to be fitted with the Submarine Signal Company's apparatus, which is invaluable in fogs and greatly facilitates navigation. All underline closets are worked by George Jennings' special air-pressure system.

The accommodation for owner and guests comprises drawing and dining rooms, library, smoking room and other saloons,



THE FOUR-CYLINDER TRIPLE-EXPANSION PROPELLING ENGINE OF THE STEAM YACHT IOLANDA.

owner's state rooms and many guests' rooms, bath rooms, etc., handsomely fitted throughout. The general style of decoration is Queen Anne and early Georgian. The officers', servants' and crew's quarters are also very spacious, and arranged to accommodate about eighty persons.

The beautiful hardwoods are a special feature. The smoking room is paneled and framed with Genoa walnut, dull polished with egg-shell gloss. The framework and panels of the drawing room are in Honduras mahogany, flatted white, while the fitments are of West India satinwood, with panels of East India satinwood. The entrance hall and dining room, which are en suite, are treated in three different species of oak. The owner's private sitting room is paneled with beautiful pale green tapestry, and the framework, moldings, fitments and panels of fitments are in hardwood veneers. In the various other cabins are some beautiful examples of Italian walnut, light oak, curly oak, pollard oak, dark oak, linden, patapsco, East and West India satinwood, hardwood and sycamore.

The electric light fittings are from very chaste designs, specially prepared, and they are finished in dull gold, old brass and oxidized silver, respectively, and all the door furnishings, electric light switches, bell pushes, etc., are in metal, also to special designs, and finished to be en suite with the various electric light fittings. The windows of the principal saloons have sliding shutters, glazed with antique Venetian and muffled white glass, while the doors and over-doors of the state rooms are glazed with specially prepared designs in cloisonné glass.

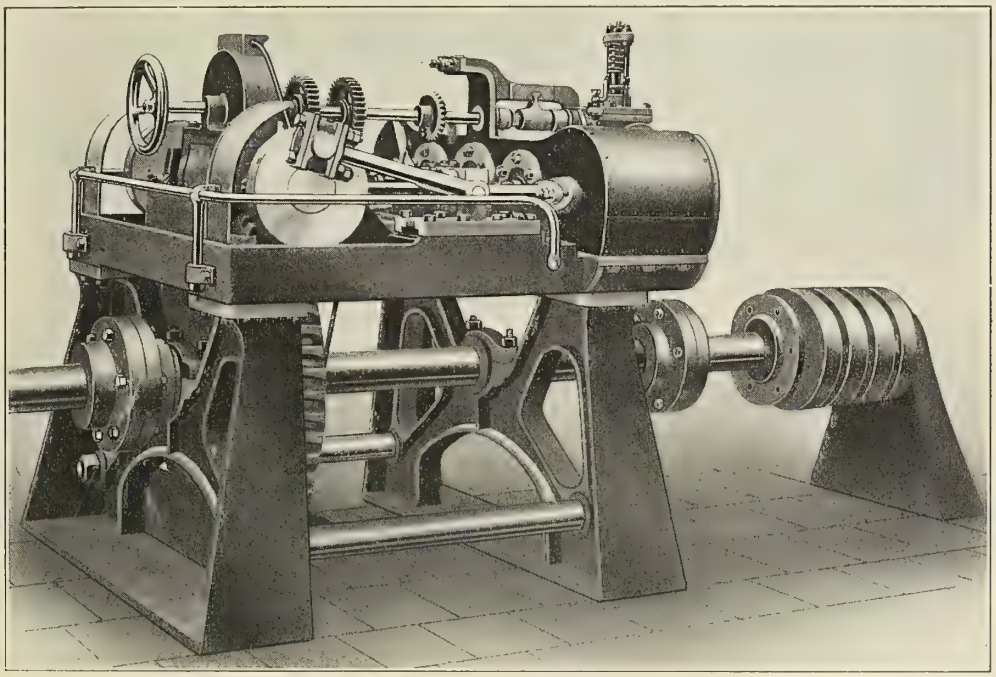


FIG. 1.—THE MCFARLANE GRAY STEAM STEERING GEAR.

NOTES ON STEERING GEAR.

The first successful steam steering gear was invented by McFarlane Gray in 1866, and the form of gear he patented is still fitted in almost all cargo steamers of moderate size. This gear is illustrated in Fig. 1. Steering chains are led to this engine from a quadrant or tiller fixed on the rudder-stock. The first cost of this form of steering gear is low, and as this factor bulks largely in ordinary cargo steamers, it is generally fitted in them.

In steamers over 400 feet long, steering gears working with chains are not so frequently fitted, as the upkeep of the chains is considerable, and the risk of a breakdown is multiplied by the number of links in the chain. Large cargo steamers, and almost all passenger steamers, are therefore fitted with some form of steering gear which acts directly on the quadrant or tiller. Three of these types are illustrated in Figs. 2, 3 and 4.

Fig. 2 shows a steam steering engine acting directly on a screw which is connected to the rudder-stock through a crosshead. This form of gear is very suitable for yachts, as it is practically silent in its action. It has the defect of being rigid, and as the rudder is apt to receive severe shocks in heavy weather, it has been found of great advantage to introduce some form of spring which will absorb these shocks.

Fig. 3 shows a design of the "Wilson-Pirrie" gear. In this gear a tiller is keyed to the rudder-stock, and it is connected by means of springs to a quadrant, which is free to move on the stock. Any shocks which the rudder receives must be transmitted through the springs before they reach the gearing. The steering engine is fitted with a pinion wheel, which engages with a toothed rack on the face of the quadrant.

Fig. 4 shows an alternative form of steering engine, which acts entirely through spur gearing instead of through a worm and wheel, as in the case of the engine shown in Fig. 3. A further advantage of the steering gear shown in Figs. 3 and 4 over the form shown in Fig. 2 is that, even if the gear should get out of proper alinement, due to movements in the structure of the vessel, no serious trouble will be caused, whereas when a gear, such as is shown in Fig. 2, gets out of line, the stresses on the driving pins of the rudder crosshead become very great, and the pins are apt to be broken.

A considerable leakage of steam takes place in steam steering gears when they are at rest, and in order to overcome this several devices have been employed. Fig. 5 shows the "patent economic" stop valve used by John Hastie & Company, Ltd., Greenock. The leakage of the steam is due, not so much to a badly fitting controlling valve, as to the fact that this valve does not close when the engine returns it to its

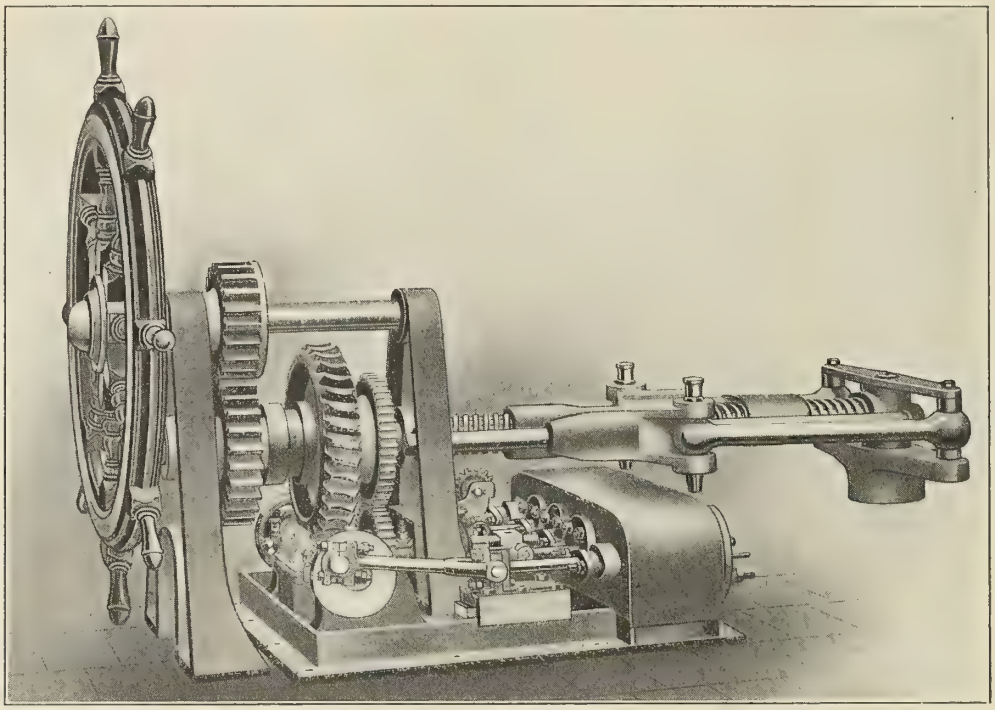


FIG. 2.—SILENT TYPE OF STEAM STEERING GEAR.

normal position. It will be readily seen that, when the valve nears the central position, it gradually cuts off the steam supply to the engine, and as the engine is operating the closing mechanism, it ceases to work when the steam supply is reduced to a certain point. The result of this is that the control valve remains open, and a blow through takes place.

The "economic" valve chest contains a valve *A* having the usual guide on the under side. Above the valve is a piston *C* of greater area than the valve, and having a small hole in it to allow the steam to pass to its top side and cause the piston to be in equilibrium. A passage *D* leads from the space on the upper side of the piston to a chest *E* containing a little slide valve *F* working over a single port. This slide valve moves in unison with the control-valve spindle of the steering engine, and opens the port, whichever way the control-valve spindle is moved.

The action of the valve is as follows: When the quartermaster on the bridge opens controlling valve *G*, simultaneously the links *H*, fixed to control-valve spindle, move, through the links *I J* and rod *K*, the slide valve *F*, which, uncovering the port *L*, allows the steam on upper side of piston *C* to escape. This destroys the balance of the piston, and the boiler steam on under side pushes up the piston, and opens the valve *A*, which allows steam to pass to the engine. Whenever the hunting gear brings the control valve back approximately to the central position the slide valve closes; the steam passing through the small hole causes equal pressure on both sides of the piston, and the spring outside the cover causes the valve to shut quickly, thus absolutely preventing any passage of steam until the wheel is again actuated by the quartermaster.

The steering engine built by Williamson Brothers' Company, Philadelphia, differs from other makes, in that the worm on the crank shaft is in halves, and that its thrust is independent. Being in halves it permits taking up the wear, and allows a quiet running of the machine throughout its life. The independent thrust prevents putting any spreading force on the

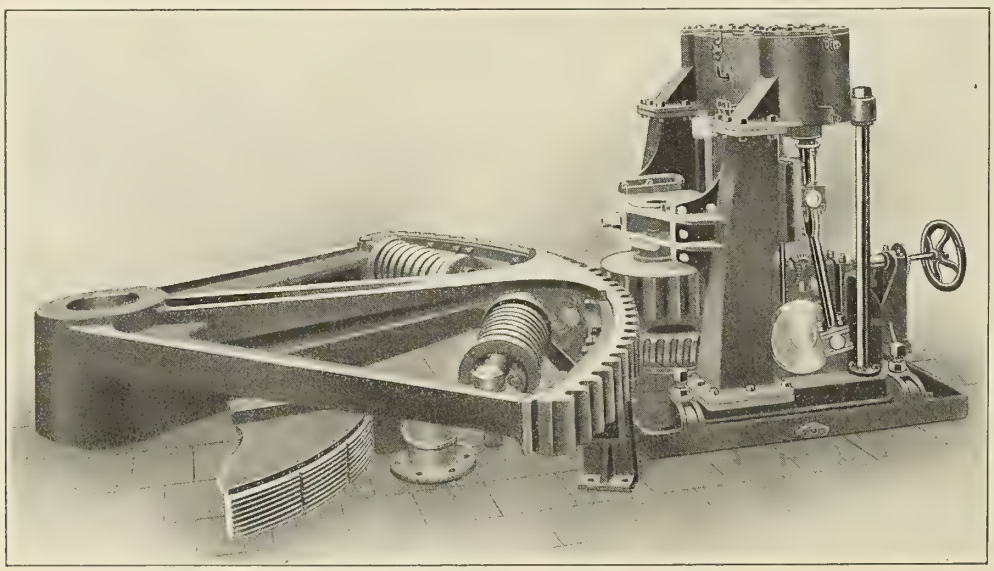


FIG. 3.—THE WILSON-PIRRIE GEAR, WITH SPRING-CUSHIONED QUADRANT.

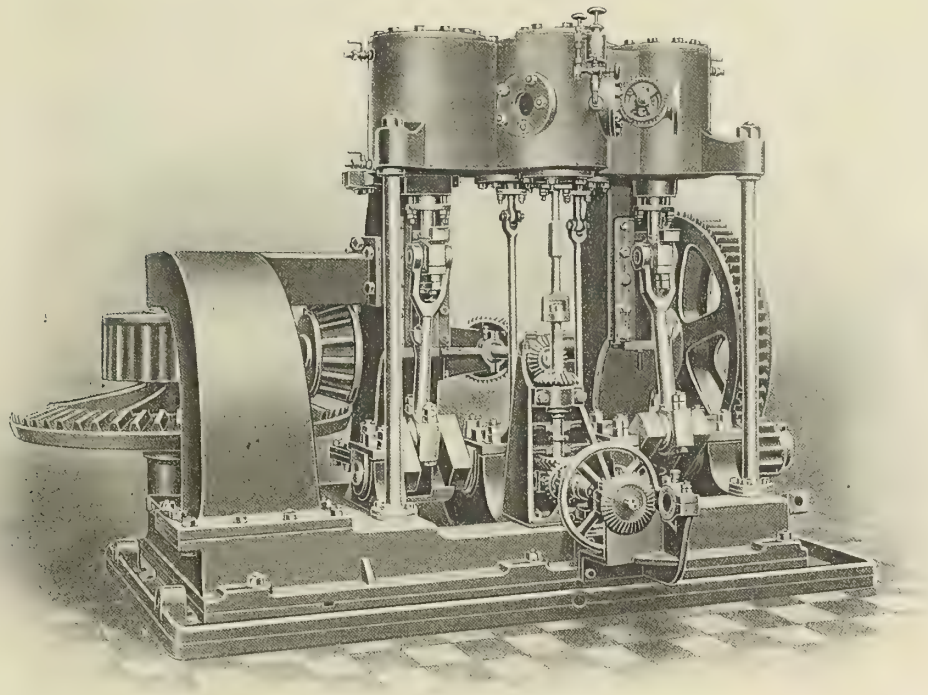


FIG. 4.—HASTIE'S STEAM STEERING GEAR, OPERATING ENTIRELY WITH SPUR GEARING.

housing, and subjects the crank shaft to only a torsional stress.

These engines are designed to control the movement of the rudder by either steam or hand, the latter being fitted only as a precaution in case of accident. In this engine the turning of a wheel on the column shaft disconnects the drum from the worm wheel, and enables the control of the rudder to be maintained through the same wheel, which, under other

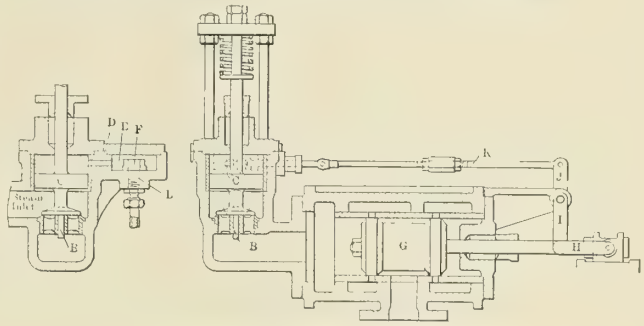


FIG. 5.—HASTIE'S PATENT ECONOMIC VALVE.

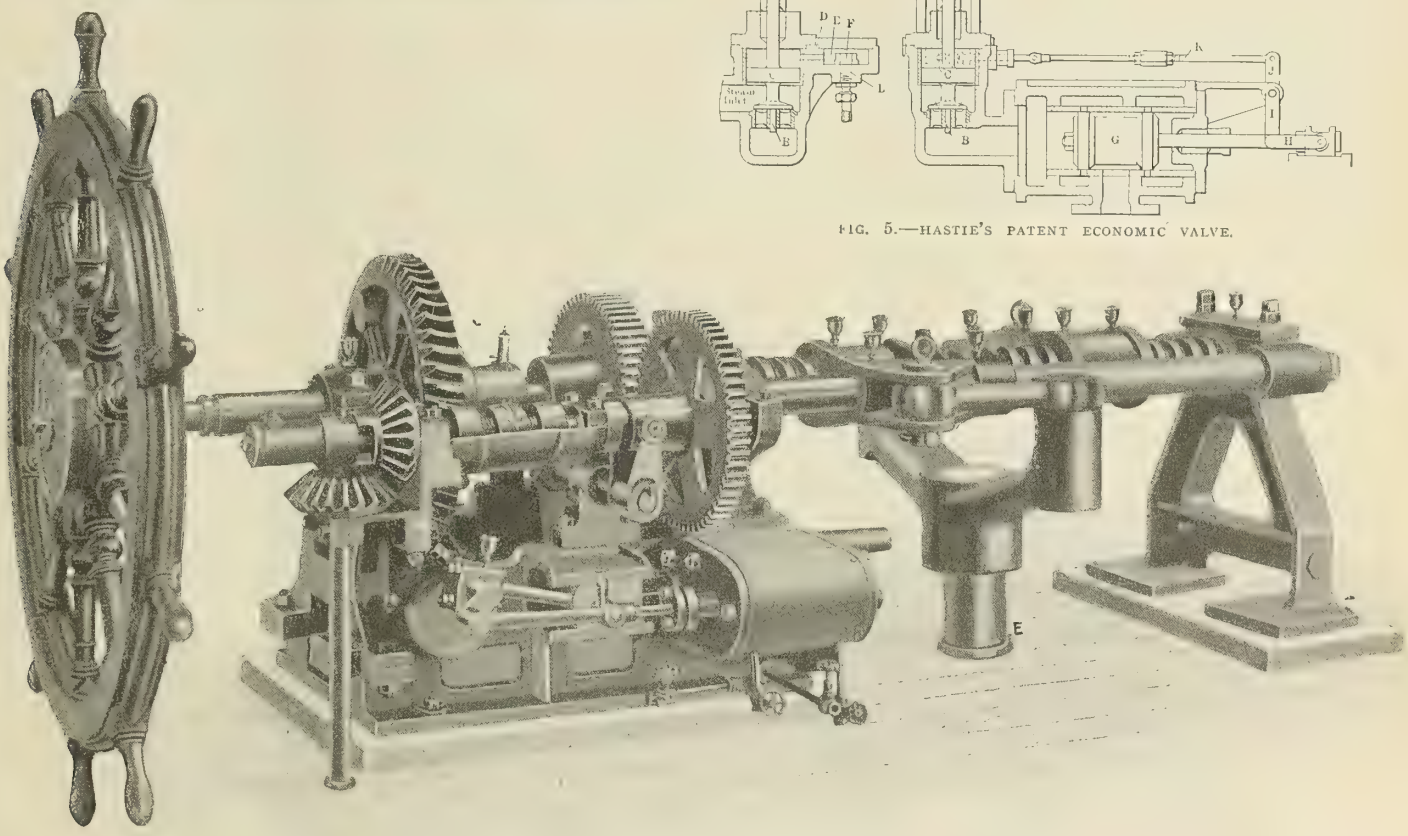


FIG. 6.—WILLIAMSON BROTHERS' COMBINED STEAM AND HAND SCREW STEERING ENGINE OF THE WORM-GEAR TYPE.

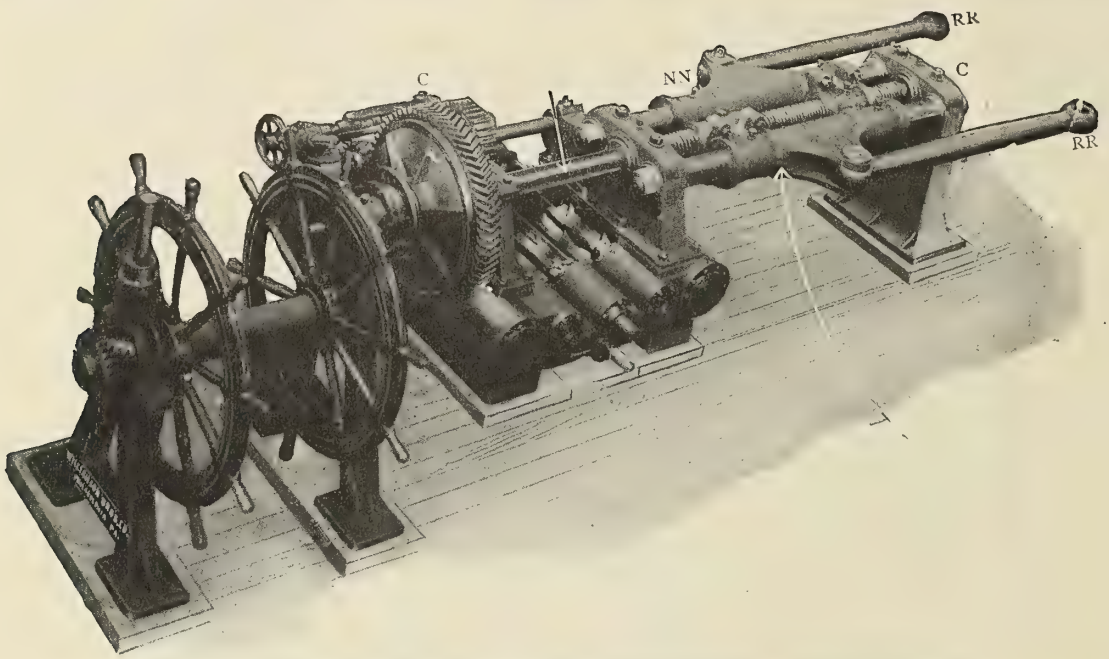


FIG. 7.—WILLIAMSON BROTHERS' STEAM AND HAND STEERING ENGINE OF THE SCREW-GEAR TYPE.

circumstances, operated the engine. The screw-gear type of this design is in use on very many battleships and cruisers in the United States navy.

The main shaft is extended beyond the machine, and is coupled to a screw, half of which is threaded right-handed and half left-handed. Two nuts on this screw are bolted to sleeves, guided by shafts, one on either side. Through pins in the sleeves and the rudder head, connections are made by links. The rotation of the screw naturally causes opposite movements of the links and turns the rudder.

To provide for any contingency which may cut off the steam supply, the screw may be operated by hand by disconnecting the clutch on the main shaft from the gear, the latter being a running fit. The two illustrations show such an engine, in one of which the rudder is entirely aft of the machine, while in the other the machine is located partly over and aft of the rudder.

The operation of a steering engine from the pilothouse is accomplished in four ways. The engine may be directly under the pilothouse, and is then operated by the extension of the shaft in the column to the gear on the automatic shaft. Again, when the engine is in its usual position aft, it may be operated through shafting and miter gears, through a wire rope, or through a hydraulic telemotor. In the latter case, the movement of the steering wheel causes a movement of the liquid from the cylinder in the pilothouse to one close to the steering engine, the piston rod of which is extended to permit connection with the automatic device for opening and closing the reverse valve.

In the Forbes steering gear (Hoboken, N. J.) the designer has departed somewhat from the generally accepted design of steering engines. The simplicity of the returning mechanism of the distributing valve is one of its principal features, this control being obtained by a worm wheel, which meshes into the worm on the crank shaft, and this worm wheel is threaded. Another departure from common practice is the use of piston valves. The vertical type here shown is particularly well adapted for the engine room, where it can be made fast to the

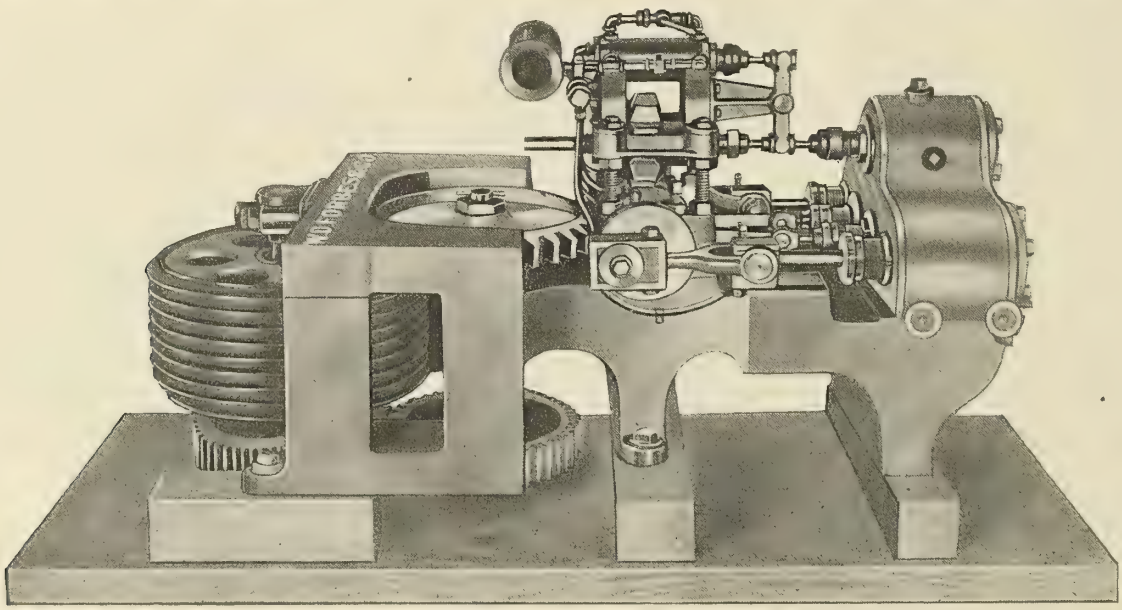


FIG. 8.—HORIZONTAL TYPE OF FORBES STEERING ENGINE, WITH DRUM FOR WIRE ROPE LEADS TO RUDDER QUADRANT.

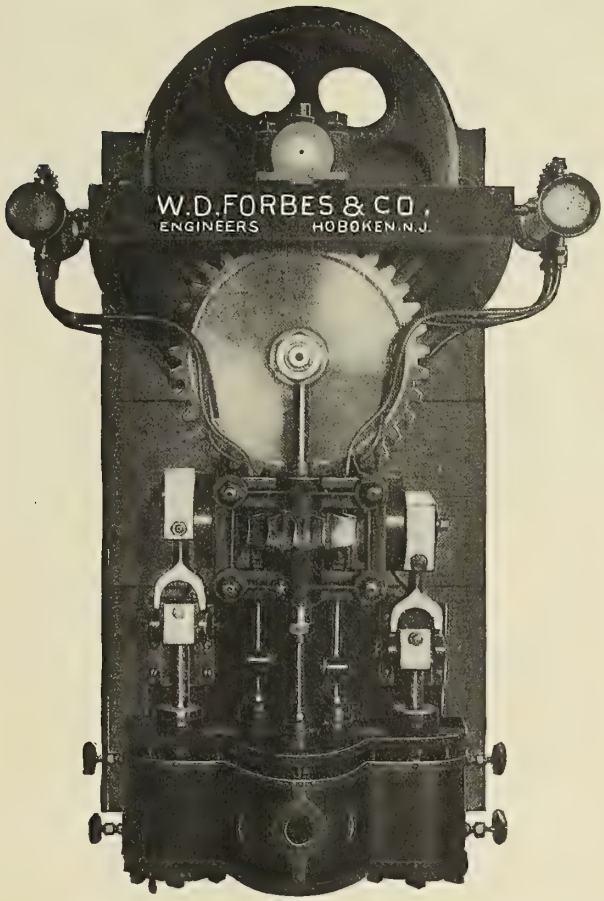


FIG. 9.—FORBES STEERING ENGINE, VERTICAL TYPE.

bulkhead; it would seem that the proper place for a steering engine would be where it can have the proper care of the engineer. The Forbes horizontal type of gear differs from the vertical type only in the cylinders being horizontal. The illustration shows a drum fitted with wire rope, but a sprocket wheel system may be employed in place of the rope.

A feature in the Forbes gear, which is not always fitted, but which is certainly a very great advantage, is shown in the view of the horizontal gear. Here an oil tank leads to a cylinder and completely fills it on both sides of a piston, which in normal conditions is central. This piston is fitted to a rod which extends down through a stuffing-box, and is connected to a double-armed lever, the other arm being fitted to the controlling valve stem. The latter, on being turned by the trick wheel, either rises or falls, and in so doing actuates the lever. The oil in the cylinders is thus displaced, and forced through the various oil tubes to the bearings. In other words, this is an automatic system of oiling; and when the steering engine is placed aft, or in a difficult place to reach, this system is most satisfactory, and is a great oil saver.

In most designs of steam steering gears there seems to have been a misunderstanding as to the work that these engines perform. Their bearings are made small, on the assumption that the work on them is very light, and that only occasionally are they run at full speed, and then for a very short period. While the short period idea is true, observation will show that steering engines are worked almost all the time. The Forbes bearings are unusually large, and the result has been most satisfactory.

The steering columns hardly come under the heading of steering gear, although they are most important factors. One of the weak points of steering gears of to-day is the connection with the controlling column and the gear itself, which in most cases is nothing but a small wire rope. It is to be wondered that so few accidents occur from the parting of this insignificant connection between the brain which makes the ship's course and the mechanism which controls it.

A type of steering gear fitted for both hand and steam work, and so designed as to minimize the strains on the acting parts, has been developed by W. H. Harfield, London, and is illustrated by two drawings. This gear is operated by means of an eccentric pinion and corresponding quadrant, the design being such as to provide increased power as the helm is put over,

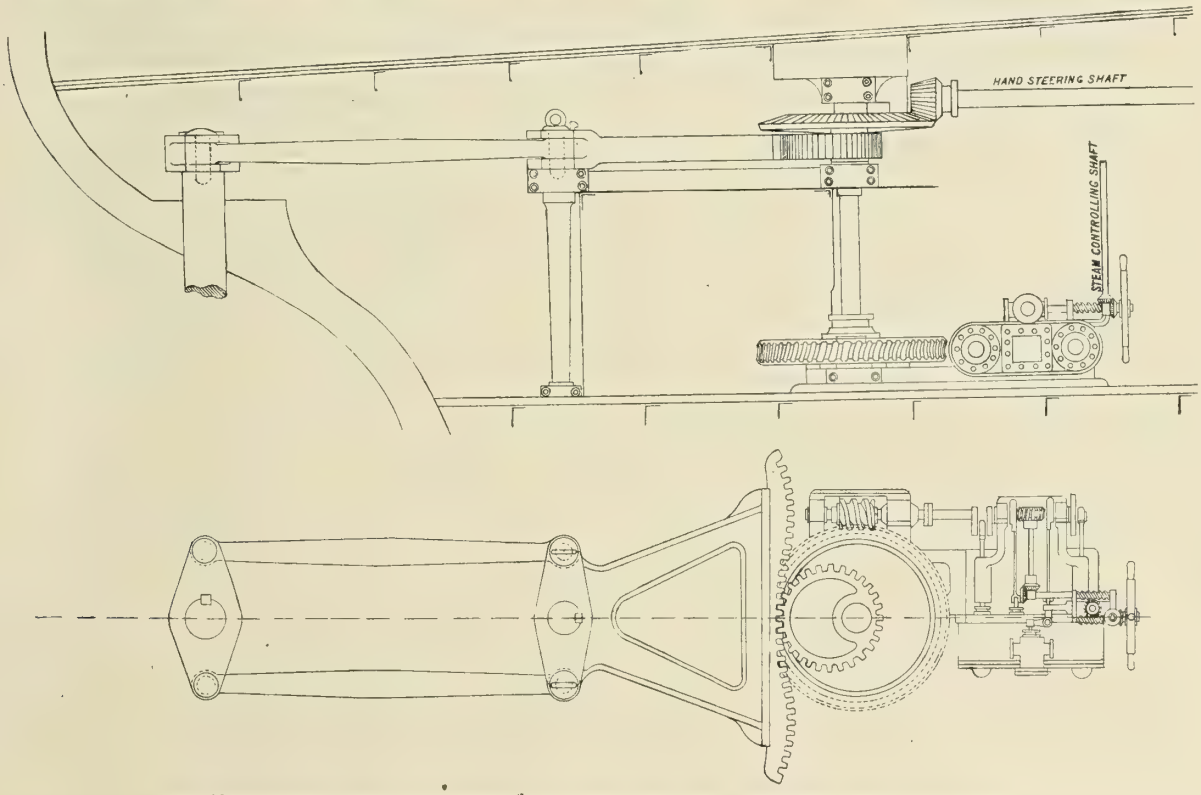


FIG. 10.—GENERAL LAYOUT OE HARFIELD'S COMPENSATING STEAM AND HAND OPERATED STEERING GEAR.

with the double result that there is quicker motion where the loads are light (thereby enabling the ship to sooner begin turning) and slower motion with increased power as the loads become greater. The bending strength of each of the teeth of the compensating rack, which is made of steel with machine-cut teeth, is above the torsional strength of the rudder head, and, as an extra precaution, there are never less than two teeth in gear with the pinion at the same time.

Tests of this gear on a large steamer showed that the stress on the links to the rudder cross-head increased almost uniformly with the angle of the rudder, from nothing at zero inclination to 70 tons at 35 degrees inclination. The stress on the teeth of the worm wheel increased from nothing at zero inclination to 4.3 tons at 35 degrees. It might be mentioned, however, that between 15 and 35 degrees the stress on these teeth was never less than 4.3, nor more than 4.7 tons, while the stress on the links increased from 22½ tons at 15 degrees to the maximum of 70 tons. The teeth on the pinion underwent stresses increasing from 6.22 tons at 15 degrees to 14.58 tons at 35 degrees.

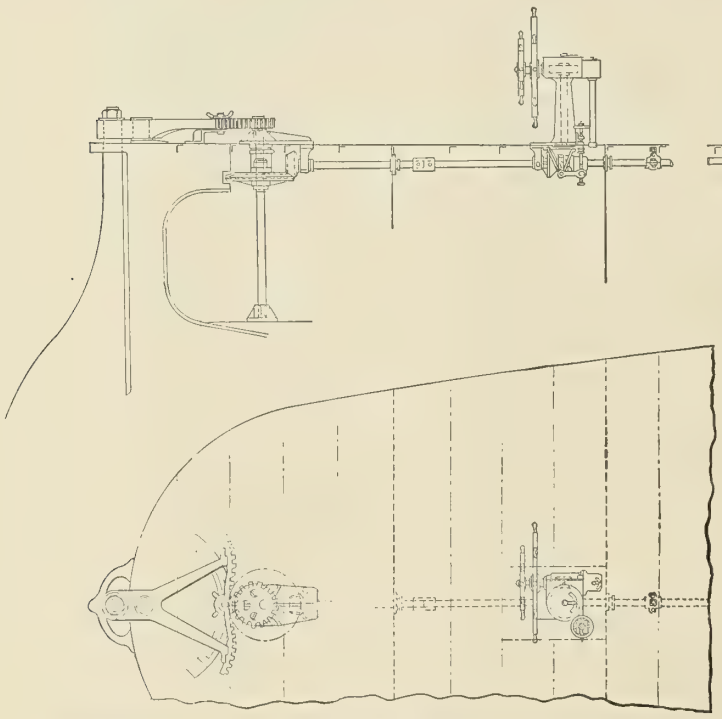


FIG 11.—THE HARFIELD GEAR FITTED TO A TORPEDO BOAT DESTROYER.

Another sketch shows the application of this gear to the British torpedo boat destroyers of the river, ocean and coastal classes.

THE HYDRAULIC TELEMOTOR.

In modern steamship practice the steam steering engine is often directly attached to the rudder-head, thus doing away with chains and wire ropes leading from the steering engine, amidships, to the rudder-head, as in the older method. It is held that this arrangement obviates the danger of breaking these ropes and chains, as well as doing away with the objectionable noise. The method of operation in many cases has been by a line of shafting running in a great number of bearings, with bevel wheels and Hooke's joints where the shafting deviates from a straight line. With this method of operation, the steering wheel is very hard to work, as the friction of the gearing and shafting is considerable.

By means of the hydraulic telemotor there is practically no friction on the line of communication between the steering wheel and the steering engine, even when passing around corners in order to avoid cabins, and under decks. The telemotor, located on the bridge, is constructed of gun-metal, so as not to affect the compass, while the motor cylinder aft is of similar metal, and the pipes are of solid drawn copper, ⅜ inch to ½ inch in diameter, according to the length of the vessel.

When the apparatus is fully charged with fluid, any movement of the steering wheel and its piston will cause a corresponding movement in the piston aft, and therefore of the valve gear of the steering engine. In cold climates, 30 percent of refined glycerine is added to the fluid, which keeps the parts lubricated and resists frost to about zero Fahrenheit. A glycerometer and thermometer are provided with the telemotor equipment, so that it is possible to test the actual proportion of glycerine in the fluid at any time. It is said that water containing refined glycerine to the extent of 50 percent is safe to work at 20 degrees below zero, and with 60 percent it remains a non-freezing fluid at 30 degrees below zero.

This steam tiller and telemotor has been installed by Brown Brothers & Company, Ltd., Edinburgh, on the two new Cunarders *Lusitania* and *Mauretania,* as well as on the turbine steamer *Carmania,* and the *Caronia, Lucania* and other ocean steamers of this line operating with reciprocating engines. This device has also been installed on many of the battleships and cruisers of the British, German, Russian and Japanese navies.

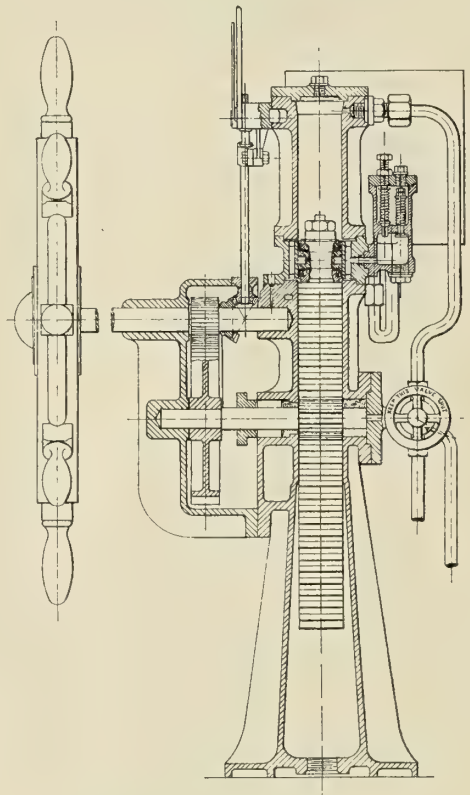


FIG. 12.—SECTION THROUGH HYDRAULIC TELEMOTOR.

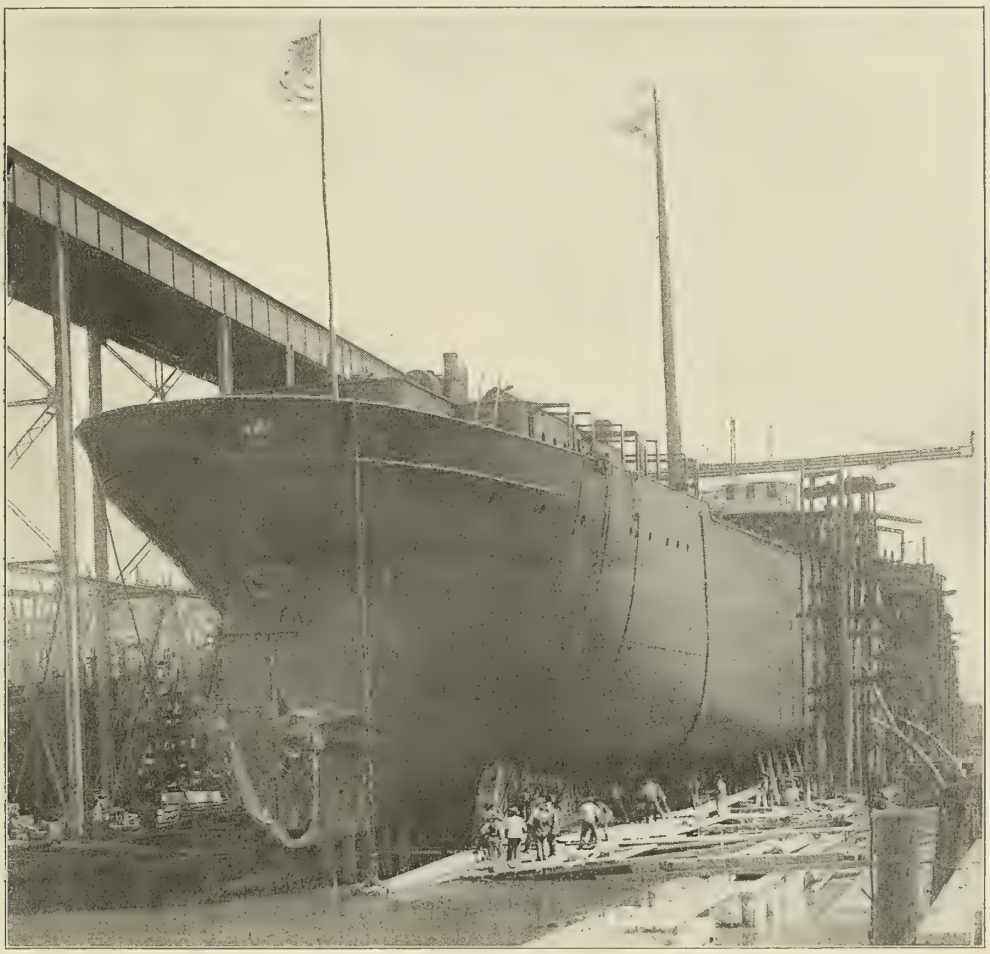
The Steamship Texas.

This oil-tank steamship was launched April 21 by the Newport News Shipbuilding & Drydock Company, Newport News, Va., for the Texas Company, New York, from plans and specifications prepared by Matteson & Drake, New York. She is of about 8,000 tons gross. Her main dimensions follow:

Length, after side of stem to after part of spar deck	410 feet	
Length, after side of stem to fore side of sternpost	397 "	
Molded beam	52 "	
Molded depth to spar deck	30 "	
Molded depth to main deck	22 "	6 inches
Sheer forward	5 "	4 "
Sheer aft	2 "	10 "

The vessel is to be schooner rigged; will be fitted with two steel masts, staysails and trysails, and three cargo booms on foremast and two on mainmast for handling general cargo. The cargo oil capacity is of 47,500 barrels crude oil; or 56,000 barrels (42 gallons) of refined oil, at a mean load draft of not over 24 feet. She is classed 1-3/3-L-I-I, spar-deck type, Bureau Veritas, and built under special survey of that society. There are two cofferdams, one aft and one amidships.

The deck machinery and outfit include one Chase Machine Company (Cleveland) 18 by 20-inch towing machine for 2¼-inch diameter steel wire hawser; a 12 by 12-inch windlass, forward; 8 by 8-inch capstan, aft; four Chase Machine Company 8 by 8-inch mooring engines; one Ford patent towing chock, besides the usual complement of bitts, chocks, etc., and steam steering gear.



STERN OF THE TANK STEAMER TEXAS, JUST BEFORE SHE WAS LAUNCHED AT NEWPORT NEWS.

She is a spar-deck type single-screw steamer, with machinery in the after end. Two continuous decks run from stem to stern, and there are a raised forecastle and bridge deck, and orlop deck in package freight hold. The hold is divided by oiltight and watertight transverse bulkheads, and an oiltight centerline bulkhead, into compartments for fourteen oil tanks, fuel-oil tanks, pump room, cargo hold forward, machinery space aft, and peak trimming tanks at ends. A continuous expansion trunk is provided between decks, with spare fuel tanks in wings. Double bottom is fitted under boiler and engine space for feed water and ballast. Space around the boilers is utilized for coal bunkers, and a cross-bunker provided forward of the boiler space. The steel bridge deck and bridge house accommodate the deck officers, with a wooden pilot house above. Officers' mess room, galley and chief engineer's and cooks' rooms are located in steel deck-house aft. Seamen and firemen, assistant cooks, oilers, pumpman, store rooms, etc., are located between decks aft.

The main engine is a vertical inverted triple-expansion, box-guide type, surface condensing, with three cranks at angles of 120 degrees. The cylinders are 27, 44 and 74 inches in diameter by 51 inches common stroke of piston. The engine is designed for maximum speed of 75 revolutions per minute. There are an independent condenser; main and auxiliary feed pumps, donkey pump, water service and sanitary pumps, fresh-water pump, circulating pump, bilge pumps, etc.; an auxiliary condenser, evaporator, feed-water heater and steam heating and fire systems.

Three single-ended Scotch return tubular boilers, 190 pounds pressure, 14 feet 3 inches inside diameter by 11 feet over heads furnish steam. Each boiler contains three Morison suspension corrugated furnaces, with heated forced-draft system, and is equipped with Rogers' boiler purifiers, the furnaces equipped for burning either oil fuel or coal, interchangeably. There is a complete electric light outfit and a searchlight. The guaranteed sea speed, loaded, is 11 knots.

NOTES ON THE FORM OF HIGH-SPEED SHIPS.*

BY A. E. LONG, M. A.

The following notes upon some of the different forms which may be used for high-speed ships are intended mainly to promote discussion upon a subject which is of interest to all designers, even if they have not had the fortune to be engaged in the design of such vessels themselves. In this connection it is also well to remember that the freak of to-day may perhaps be the orthodox vessel of to-morrow. As the subject in its entirety is much too large for a single paper, it will be well to commence by stating the limitations to the scope. The length and displacement are supposed to be already determined upon; also in a general way the curve of sectional areas; our inquiry is therefore limited to the study of the form into which the leading elements already fixed can be put. "High speed" is taken as high, relative to the length of the vessel—not merely absolute speed; thus, from this point of view, the *Mauretania* is a slow vessel, and small vessels of less than half her speed are very fast. The lower limit of speed fixed upon is $2\sqrt{L}$, and even this is much too low to bring out the true characteristics of some of the types. Elementary straight line figures of fixed length and displacement are herein used for a comparison of type, because the types are clearly differentiated, and overlapping is avoided.

In actual practice it is sometimes difficult to classify a ship as belonging definitely to one type, for vessels are in nearly all cases—except, perhaps, racing motor boats—a compromise between speed and other necessary requirements. The vessel as built is rarely the designer's ideal of a speed form, pure and simple, and is in many cases far from it. Sometimes we meet with a vessel whose designer has obviously set out with very definite ideas as to type, but in the course of his labors his heart has failed him, and relicts of older ideas appear, which are incongruous with the ideal, and really detrimental to it. In some of the compromises of type which are frequently met with, the designer has annexed much more of the defects of the two types that he has amalgamated than their virtues.

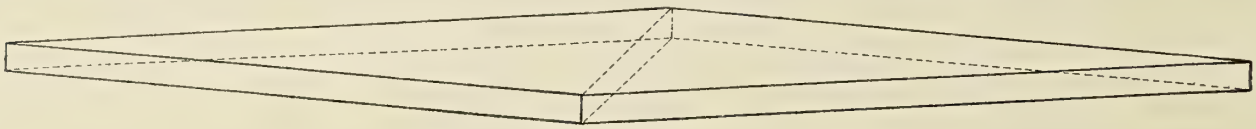


FIG. 1.

A secondary advantage of these simple figures is that we can deal with the forms in the abstract, without any troublesome inquiries as to whether this is, or is not, someone's favorite design disguised.

FIVE FORMS COMPARED.

The five forms chosen, *A, B, C, D, E,* are shown in Figs. 1, 2, 3, 4, 5, and their leading elements are given in the table. For simplicity the forms are shown in quasi-perspective, and the part above water omitted.

Type A.—This comes first on our list for many reasons, among others that it is practically the only type in use for vessels of less speed than our limit, and is the only one recognized by many people as a speed form at all. Another claim is its great antiquity, as we see it in the beautiful form of the Viking ships dug up in recent times. Its intrinsic merits are also great, and it is much to be regretted that for the very high speeds with which we are dealing it is practically impossible to use it. The merits of the form, besides the value of the great experience which we have had in its use, are fairly obvious. First, it is a very easy seaboat, on account of the well balanced wedges of immersion and emersion, both in a longitudinal and a transverse direction. Secondly, the transverse sections being deep at the ends, and in practice generally sharp, there is an absence of the violent thumping shocks which occur under certain circumstances in some of the other forms. Thirdly, the wetted surface is small.

The defects are: First, the longitudinal and transverse stability are relatively small; secondly, the change of trim when driven at speeds much beyond that economical for the length is so excessive as to be prohibitive. This change of trim, moreover, is more nearly what is ordinarily known as such, namely, an actual depression of the stern and elevation of the bow, than what occurs in some of the other types, where the change of trim relative to the horizon is very largely a lifting of the fore body and a reduction in the total displacement. In small vessels which are not intended to be always run at the maximum speed, it may be possible to correct this defect by fitting a movable fin at each side of the after end, set at a slight angle to the horizontal, so as to act as a hydroplane. These fins might either be arranged to hinge up against the side when not in use, or could be fitted to slide in and out, after the manner of a sailing vessel's centerboard. Some Canadian steam yachts are fitted with contrivances of this nature, known as squatboards, but they are placed horizontally and are fixtures. The effect is said to be very marked, but from a seagoing point of view such a structure, if fixed, could have no advantage over an ordinary flat form of hull.

Type B.—In this type, which is practically that of all modern torpedo boats, destroyers, etc., we have the same forebody as in *A*, but a horizontal wedge is substituted for the original vertical one for the after-body. The area of the waterline is increased 50 percent, and there is a corresponding increase in the stability, both longitudinal and transverse. The

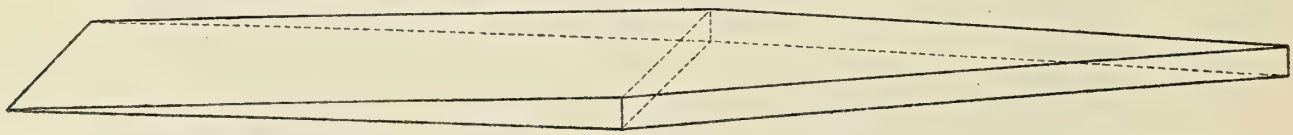


FIG. 2.

wetted surface is 13 percent greater, but at high speeds it is probable that this is not really the case, owing to the vertical lift of the ship; the wave making aft is also so flat that there is less increase of surface there in contact with the water than in *A* under similar conditions.

The advantages are: First, the great increase in longitudinal and transverse stability, the latter being in small single-screw vessels a matter of vital importance, owing to the great torque of the propeller. Secondly, great reduction in the change of trim, and the fact that it is more due to a lift of the whole body than to a tipping action, as in *A*. Thirdly, the angle of delivery is much reduced with the same volume of after-body. Fourthly, the area available for accommodation is greater, and aft is of a more suitable shape for arrangement than in *A*.

The defects are: First, the wedges of immersion and emersion are badly balanced, and the necessary result is a somewhat uneasy twisting motion in a seaway. Secondly, the

* Read before the Northeast Coast Institution of Engineers and Shipbuilders, Feb. 21, 1908.

flat form of the after-body is subject to more or less violent slamming in rough weather; in the extreme case where the sections are absolutely flat this may cause serious results, unless the structure is abnormally heavy. Thirdly, variations in draft may cause considerable differences in the resistance, apart from the actual addition or reduction of displacement, as this form of after-body is really designed for one draft only.

Type C.—We now come to a type which seemingly violates all experience acquired in the past, and to most people appears

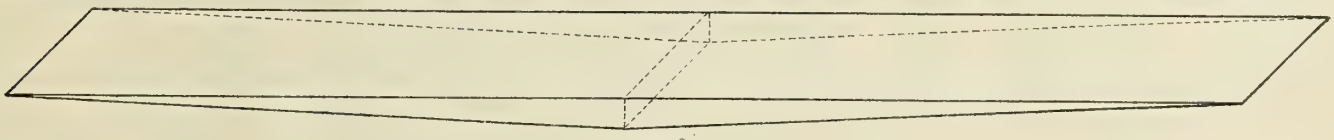


FIG. 3.

to be quite new; indeed, in a paper read before the Institution of Naval Architects in 1906 it is clearly stated to be so. A little investigation of the work of the older writers on naval architecture shows that there is really nothing new in this form; it probably originated in prehistoric times from the skimming stone with which we have all been acquainted from our earliest youth. Chapman devotes part of a chapter to a discussion of the merits of two forms which are our *A* and *C*, and comes to the conclusion that *C* is excellent for smooth water speed, but impracticable for seagoing purposes. More than half a century later, Lord R. Montague, in a very interesting little treatise on naval architecture, follows on Chapman's lines, and comes to very much the same conclusion.

Some years ago, Mr. Yarrow made a series of very interesting experiments on full-sized models for international cup racers, and some of these results are available for the general good. Mr. Yarrow's conclusion seems to have been that type *C* was the best, but he modified it by cutting off the corners of the fore end, giving a somewhat uncouth resemblance to the bow of an ordinary vessel. Looking at the lines of this vessel as given in Mr. Smith's paper, read before the Institution of Naval Architects in 1906, and numerous photographs of her when running at full speed, some curious questions arise which are worth careful consideration. Roughly, about two-thirds of the forward wedge is in the air, where it is of no further use for speed, and, in fact, is detrimental, as it presents a large area for wind and waves to act upon. Mr. Yarrow has cut away about one-quarter of this. Query—Could he not have cut away a good deal more and utilized the length saved for elongating the after-body, as the total length was limited to 40 feet?

Mr. Yarrow's experiments, and the actual performance of the vessel in a very moderate seaway, completely bear out Chapman's conclusions, reached more than a century before, so that we have here another proof, if one were needed, of the great grasp of his subject which Chapman possessed.

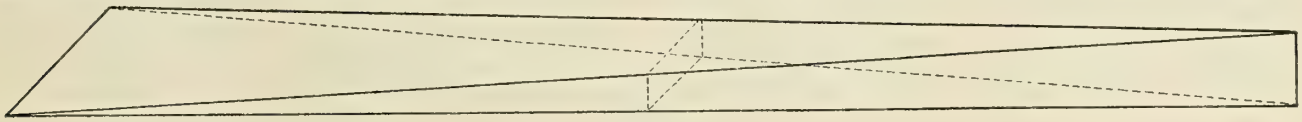


FIG. 4.

To yacht designers the form is well known, but with them its speed virtues are quite masked by the facilities which it presents for evading a length on the waterline measurement. The form itself has great merits, also great defects, and is probably one of the most interesting forms in actual use. The advantages are: First, maximum stability, both in a transverse and longitudinal direction. This merit, of course, appealed to Chapman even more than it does to us. Secondly, very fine angle for both entrance and delivery. Thirdly, maximum room on the lower deck, and of a shape well adapted for arrangement of cabins, etc.

The disadvantages are: First, great change of apparent trim; but this is quite different from the case of *A*, as it is chiefly a bodily lift of the vessel, not merely a tipping about the center, as in ordinary ships. Secondly, the slamming action in a seaway at both ends may be very violent, and a vessel of this type will require to have scantlings much in excess of those calculated in the usual way. Thirdly, the wetted surface, as will be seen in the table, is 26 percent larger than that of *A*, but this is really of little importance for high speeds, as, owing to the bodily lift, the surface is actually considerably less than that given for the still-water condition. As regards the angles given, there is also in actual work a great difference from the "at rest" condition. Forward, the angle will be greater, but a very large portion of the body there is above water; aft, the surface of the bottom will be nearly or quite horizontal, giving practically no angle, merely frictional resistance.

Type D.—We have here another curious form which at first sight appears to be of very recent invention; but, as in the case of *C*, the origin is probably old. An instance of it in a fairly pronounced form is seen in the Northeast Coast coble. Yachtsmen have also been familiar with it for many years in the well-known "raking midship section;" in fact, this is the raking section carried to its logical conclusion. In this type in the table the breadth has been increased, also the draft at center; for, if the breadth had been retained, the draft required would have been too great. As shown in the table, the coefficients also differ, the block being less and the prismatic more. The curve of sectional areas is a common parabola, being thus rather fuller than is generally found in ordinary forms. In practice the curve would probably be rather finer at the ends, as the fore foot would be somewhat rounded off, and the keel line right aft slightly hollowed, coupled with a possible rounding off of the corners of the waterline. As this type is really a further development of *B*, its merits and defects are much the same in character, but accentuated. As to accommodation, the fore end is too fine to be of much use, and the after end inconvenient in shape. The wetted surface is not quite so large as that of *C*, but when running at high speeds it is probably larger, as this is a type not intended to lift much forward. The transverse and longitudinal stability are not satisfactory, considering the large increase of breadth.

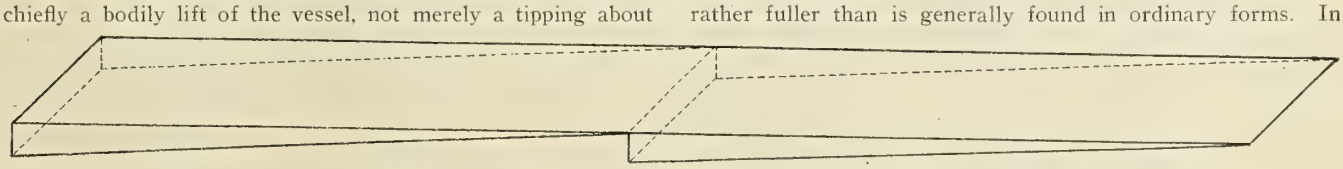


FIG. 5.

In a seaway, such a vessel would almost certainly be very wet and uncomfortable, and in some conditions dangerous.

The case of the coble, however, shows that, modified, a good sea boat may result, at least in small sizes; whether a large coble would be a desirable vessel is open to question. The great difficulty in docking a large craft having such a profile, unless she had considerable additions in the way of dead-

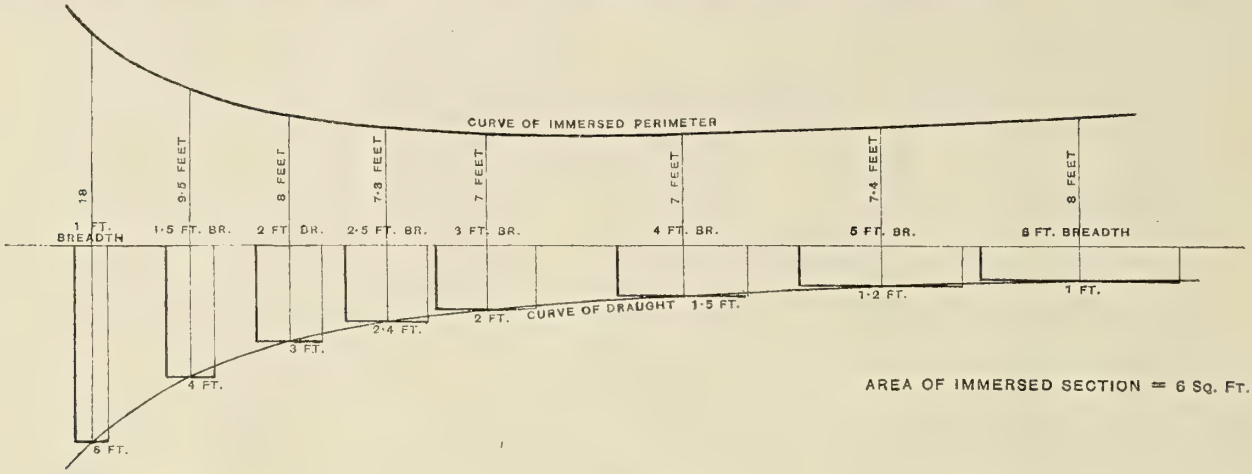


FIG. 6

wood, etc., is obvious. The French motor boats of this type seem to behave fairly well in the rather mild type of sea in which they have recently been tried, being superior to the rival type *C* in this respect.

Type E.—This is one of the forms of hydroplane which has been so much before the public in the last few years. Curiously enough, the sketch would do equally well as representing some of the most recent designs published, or the model submitted to the Admiralty nearly forty years ago by the Rev. C. M. Ramus, so that there does not seem to have been much progress made in this direction, so far as form goes. The power to drive it is, of course, another question. The late Mr. William Froude's report upon the trials of this, and a revised model of his own, and the articles which were written on the subject in *Naval Science* and *The Annual of the School of Naval Architecture,* afford very interesting reading. They are wholly condemnatory, but the idea still lives on, so that perhaps the reverend gentleman was nearer to the mark than his critics imagined.

It is very difficult to compare this form with the other four, as they are more or less accomplished facts, whereas this is still in a very nebulous state. Startling stories are abroad as to what can be done with one of these craft of amazingly small dimensions, but there is a painful absence of reliable facts and figures. The first thing that will strike anyone looking at the published drawings is that, even if a great bodily lift took place, there would still be a very serious eddy making behind the ends of the planes. Possibly this can be got over in time, but at present it seems to be a grave defect. As a seaboat there does not appear to be much hope of improvement. Mr. Froude gave a startling description of what would happen to a semi-flying Atlantic liner among waves. Some mechanical genius may come forward who can deal with the shocks to the structure from such usage, without taking excessive weight; and it must be remembered that light weight for the dimensions is an essential feature of the problem.

In concluding this part of the subject, the relative value of the five forms for very high speeds, so far as they have yet been tried, may be briefly noted. *A* may be summarily struck out, both on theoretical and practical grounds. *B* is the form in general use for torpedo boat destroyers, torpedo boats and many small craft in which high speed is not the only object sought; it is, in fact, the only one of the five which as yet meets the usual requirements and has been thoroughly tested practically. *C* and *D* are the rival forms for motor boats; *E* is not yet in a sufficiently practicable condition to judge of its ultimate success or failure.

In all the forms dealt with, when driven at very high speeds, some curious phenomena occur. We see a vessel in a position not momentary, but for hours together, where the center of gravity is many feet ahead of her nominal center of buoyancy, and if of one of the flat-tailed types, she has also considerably less displacement than her total weight. In the case of *E*, and also, though in a less degree, of *C*, this latter feature is intentional, and we are met with the difficult problem as to whether it is better to use a considerable part of our available

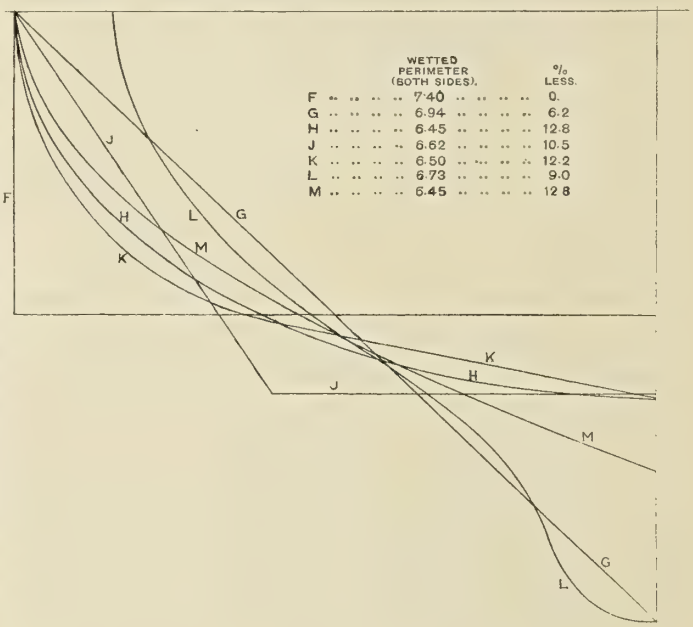


FIG. 7.

power in lifting the vessel, or to use it for driving through the water in the ordinary manner, as aimed at in *D*. That we cannot get the lift without expenditure of power is fairly obvious. If the lift causes a considerable change of trim there must also be a corresponding loss in power, owing to the angle of the shaft with the horizontal being increased, and as the shafts of all, or nearly all, high-speed vessels are already at a considerable angle, this loss alone may be serious. In *E* there is supposed to be no change of trim; in fact, this is one of the chief objects of using two or more inclined planes, but

this advantage involves serious disadvantages, at least in the crude shapes which have yet been tried. Whether or no this form can ever come into even limited use is still very doubtful.

FORM OF THE MIDSHIP SECTION.

As the shape of the midship section generally governs the form of the other sections for a considerable portion of the vessel's length, the consideration of it is important, and the following notes may be useful for discussion. In the previous part of this paper the mid section was taken as being in all cases a rectangle, whereas there is really a very large number of suitable forms to select from, particularly if the dimensions may be varied while keeping the given area. Even with the rectangle itself, the wetted perimeter may be greatly altered by varying the ratio of breadth to depth. Fig. 6 illustrates this. The areas of the sections are all alike, but the perimeter changes from 13 feet at one end to 8 feet at the other. The curve shows the wetted perimeter to a scale half that of the sections themselves. From the surface point of view, the very shallow section is considerably better than the very deep one, but the minimum is found in a moderate proportion. If, however, we also consider the wave-making resistance, we know from Rota's and other experiments that within the limits of the experiments the deeper sections yield less resistance, so much so as to overbalance the greater frictional resistance. This difference will naturally increase as we increase the speed, but there will possibly come a speed where the shallow section will, owing to its skimming action, give a less resistance than the deep.

Fig. 7 shows some of the forms which have been adopted, or proposed, all being of the same area. Section *F* does not seem to have any advantages to compensate for its large relative girth, unless there are reasons for strictly limiting the dimensions; when something approaching a rectangle may allow us to use a curve of sectional areas which would otherwise be impossible. *G* is merely the ultimate development of the rising floor, which has been a favorite feature in design in many countries and many ages. It has considerably less girth than the rectangle, but is not an economical section from the surface point of view. It involves large dimensions, and in many cases an undesirable draft. In America this is a favorite type, as will be found by a study of the many published designs, but the reason for the preference is not very clear. The resulting water, ribbon and buttock lines are very clean, easy curves, and the vertical sections of the vessel forward being sharp, there is not so much hammering in a seaway as in the flatter-bottomed types.

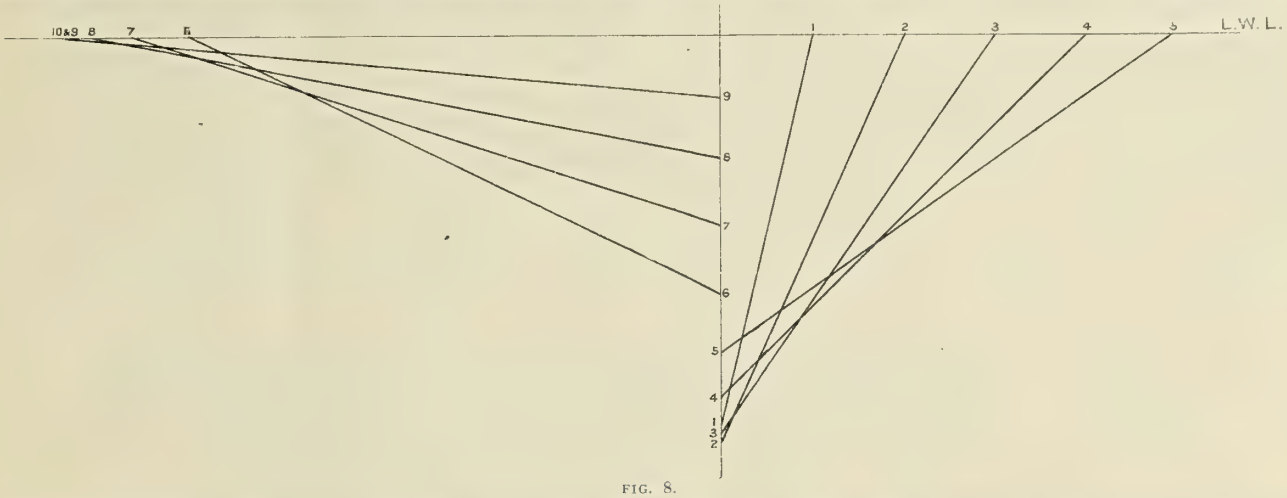


FIG. 8.

H is a true semi-ellipse, which has the great advantage of having a small girth for the given area and compact dimensions, and it lends itself very well to development into any of our forms *A, B, C,* etc. For example, in a form of *D* type, by using the elliptical sections we can gradually merge from a vertical line forward to a horizontal line right aft without abrupt changes in the horizontal lines. An objection which may be made to the true semi-ellipse is that to many people's eyes it is too lean under the bilge, and too full about the center line. Perhaps for this reason the true curve is not often met with; a very good example of its use will, however, be found in the launch *Lotus,* the lines of which appear in the *Yachtsman* of Dec. 19, 1907. *K* is a modified section which gets over this objection, but the girth has to be made somewhat greater. The section shown is constructed by describing a circular arc with a radius of one-quarter the breadth of the vessel for the bilge, and striking a tangent in from this to the center line, to inclose the required area. It is not suggested that this construction has any particular merits; it is merely given as fairly representing many sections in general use. *J,* called in America the sharpie or dory type, has been introduced here, and it crops up from time to time as having some more or less occult virtues. It yields a moderately small girth, and lends itself fairly well for use in all the forms.

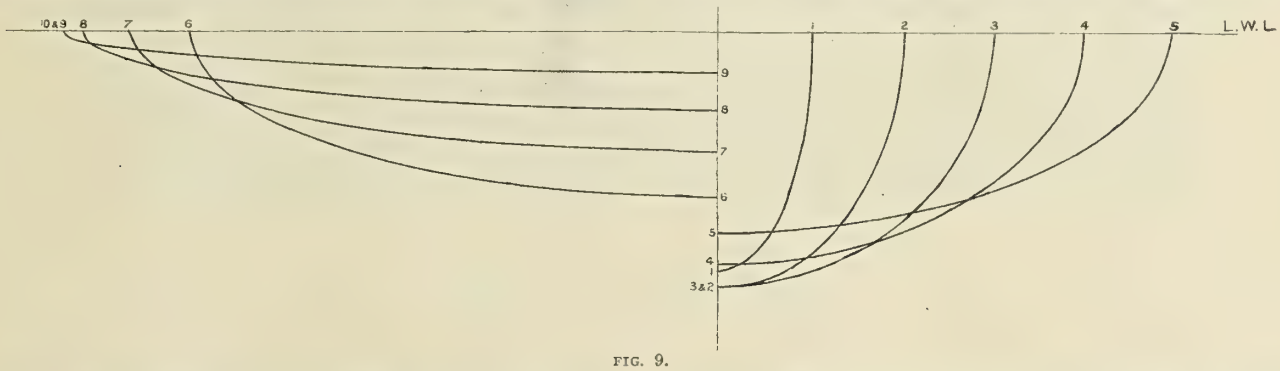


FIG. 9.

TABLE OF ELEMENTS.

Dimensions in Feet.	*A*	*B*	*C*	*D*	*E*
Length on waterline.	50.	50.	50.	50.	50.
Breadth, molded.	5.	5.	5.	6.	5.
Draft at center of length.	1.2	1.2	1.2	1.5	1.2
Draft, maximum	1.2	1.2	1.2	3.	1.2
Displacement in cubic feet.	150.	150.	150.	150.	150.
Center of buoyancy below waterline	0.60	0.50	0.40	0.75	0.40
Transverse metacenter above center of buoyancy... B.M.	0.87	2.17	3.46	1.50	3.46
Longitudinal metacenter above center of buoyancy... L.M.	87.15	178.68	347.22	140.54	347.22
Area of waterline	125.	187.5	250.	150.	250.
Area of wetted surface:					
Sides	120.57	90.28	60.	150.26	72.
Bottom	125.	187.60	250.20	150.26	250.20
Total	245.57	277.88	310.20	300.52	322.20
Area of wetted midship section	6.	6.	6.	4.5	.....
Angle of entrance	11° 30′	11° 30′	2° 45′	6° 52′	2° 45′
Angle of delivery	11° 30′	2° 45′	2° 45′	3° 26′	2° 55′
Excess area of wetted surface over *A*	0	13%	26%	22%	31%
Block coefficient, using depth at center	0.500	0.500	0.500	0.333	.....
Prismatic coefficient	0.500	0.500	0.500	0.667	.....
Breadth to give the same *BM* as *B*	6.78	5.00	4.27	6.78	4.27

M is formed of two semi-parabolas base to base. Very much the same remarks apply to this as to the semi-ellipse. The curve is a pleasing one and well adapted for use with such of our types as have deep fore-bodies. Sections *G*, *H* and *M* have the common disadvantage in that they are rather cramped for room in way of the wing shafts in multiple screw vessels, and the shafts may be an inconvenient length out board. A good deal might be written about the relative strength of these forms of midship section, but we have here dealt with them from a speed point only.

Figs. 8 and 9 are given to show how, with a fixed length, displacement, curve of sectional areas and form of load waterline, we may greatly vary the cross-sectional shape. Fig. 8 is of the triangular section form known in America as the Dolphin type. Fig. 9 has true semi-elliptical sections all fore and aft.

The sections like those given, which are mechanically constructed, such as the rectangle, triangle, ellipse, parabola, etc., are not suggested as necessarily superior to curves drawn in the usual way to suit the eye, but there is some advantage in using a constant type of curve right fore and aft, as it insures an amount of harmony between the sections which is not always found in forms constructed without it, even with good curves of sectional areas. Abrupt changes in sectional shape are common features in poor designs, and should be avoided where possible.

LAUNCHING OF THE GERMAN SURVEYING SHIP PLANET.

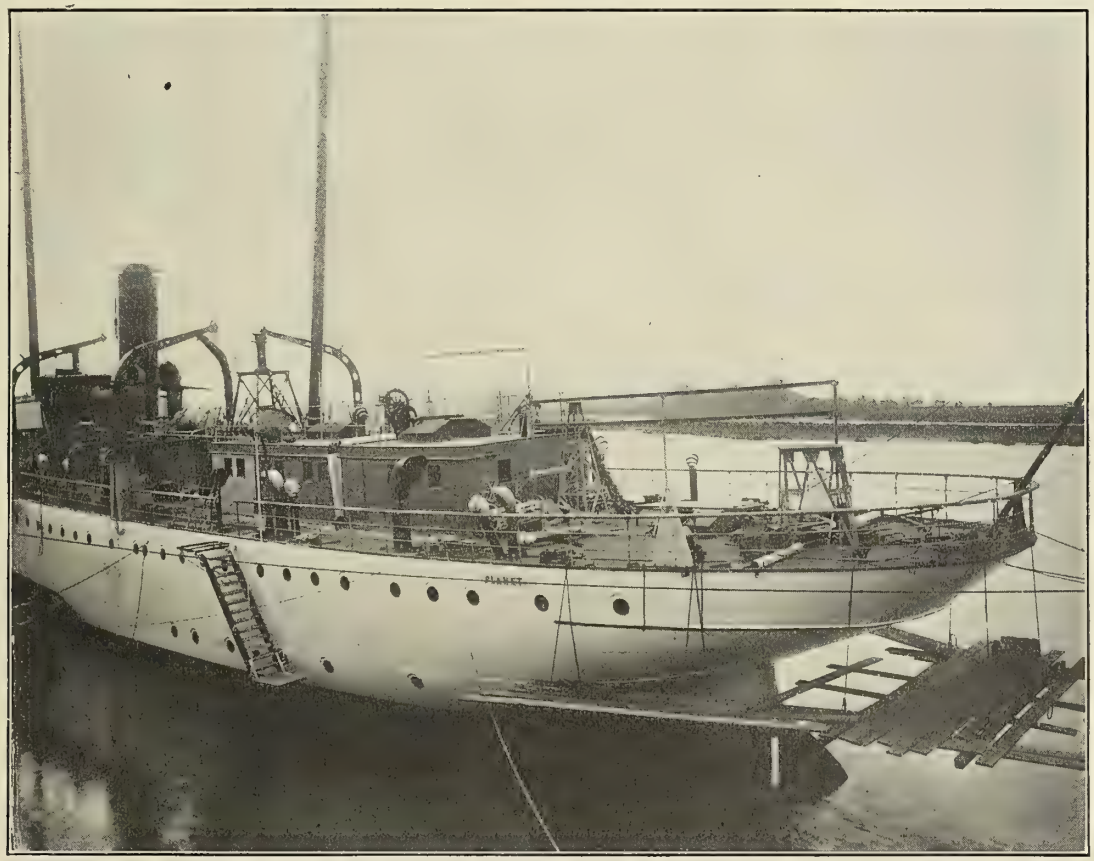
L is a very interesting section, patented by the great French designer, the late M. Normand, from whose specification it will be seen that the object sought is twofold—a reduction of breadth for the same metacentric height, and a lowering of the machinery—single screw—so as to get the shaft horizontal. The girth is large, but as the lower part of the section is merely a sort of crank-pit not more than half the vessel's length, the end sections are relatively more cut away than in the other types. A somewhat similar section is found in the very curious design *Napier*, given in Mr. J. A. Smith's paper read before the Institution of Naval Architects in 1906. In this an attempt seems to have been made to combine type *A* with a flat stern. The main body of the vessel is a pure type *A* with very fine waterlines, the length being about three-fourths of the total. On the after part of this is superimposed a flat-bottomed body of very little depth, which projects far enough aft to make up the total length, 40 feet. The vessel does not seem to have been very successful, but this may be due to other causes than the peculiar form of hull.

In conclusion, the writer wishes again to state that these notes upon the forms possible for high-speed vessels have been written mainly to promote discussion upon a subject which has not previously been before the Institution. The forms shown are at present of very limited application, such as to torpedo craft and racing motor boats, but unless the dimensions of ships can keep pace with the increased demand for speed, some such forms as these must ultimately be adopted instead of our present big ship type. Possibly in the course of the discussion our attention may be drawn to some form which is superior to any of those shown, and if that is so, then the writer will have done the Institution a good service, and have been well repaid for his efforts.

A German Surveying Ship.

The surveying ship *Planet* was recently constructed for the German navy, and is intended to replace the old vessel formerly used by that navy in connection with surveying work. The new vessel embodies all improvements of modern ship building, and is equipped with the most up-to-date scientific instruments. Eight watertight transverse bulkheads and a double bottom have been provided to increase her safety. The vessel is made from first-class ship-building steel, and, like mercantile ships, has a round stern and a yacht-shaped stern post. To the foremast is fitted a crow's nest, serving as outlook.

The rooms of the ship are exceptionally high and well aerated, as she is to be temporarily used in tropical climates; a satisfactory insulation from the outside steel hull has likewise been secured. All the apartments of the vessel are furnished according to general regulations by the German navy, except that the walls and furniture are made of wood instead of sheet iron, as in the case of warships, so as to increase the comfort afforded by the ship.



STERN OF SURVEYING SHIP PLANET, SHOWING FITTING OUT UNDER WAY AND NEAR COMPLETION.

The rearmost deck house contains a large drafting room, with files and instrument room, as well as a living room for a scientific assistant. In front of the latter, between the engine and boiler casings, there is situated the crew's galley. The four front deck houses are used, respectively as commander's room, rudder engine room, room for hammocks, oilskins and cleaning utensils, and as lavatory.

The ship is lighted by electricity, for which a direct-current dynamo for 110 volts has been installed in the engine room. In order to use the ship as well in cold climates, all the working and living rooms have been provided with steam heat. Two motor boats, 10 meters (32.8 feet) in length, have been provided in order to assist in the surveying work to be performed by the vessel; these are the first motor boats ever used on board a ship of the German navy. In addition to these, there are two whale boats and another rowing boat on board.

The ship has been equipped with means of investigating the higher strata of the atmosphere. To this effect there are used both kites and balloons. The former, which are equipped with meteorograph and anemometer, are able to rise to a height of about 5,000 meters (3 miles), and serve to measure the atmospheric pressure, temperature, moisture and speed of wind, as well as the direction of the latter.

The balloons are used in connection with investigations of the higher atmospheric strata up to 14,000 meters (8⅔ miles). Two balloons are tied together, carrying underneath a float. One of the balloons is filled with a greater amount of gas than the other, the amount depending upon the height to be reached. At a given height this balloon will explode, and the other, being unable by itself to carry the float and accessories, will drop to the earth (or sea), maintaining itself above water by means of the float for some time, until it is taken on board a boat.

As regards the oceanographical work to be performed by the *Planet,* researches on the temperature and salt contents of the water, as well as on the condition and shape of the bottom of the sea, should be mentioned. To this effect there have been installed on the upper deck a drum and two sounding machines, one of which had been used already on board the *Valdivia.* Among other researches should be mentioned stere-photogrammetrical records of the waves of the sea and the shape of the coasts. To this effect the vessel has been provided with two photo-theodolites, placed on supports at a distance as great as possible on the upper deck.

In order to test all the scientific instruments, two trips were undertaken from Kiel, one of which was confined to the western part of the Baltic. This was intended to test the balloons and kites. The other trip was directed through the

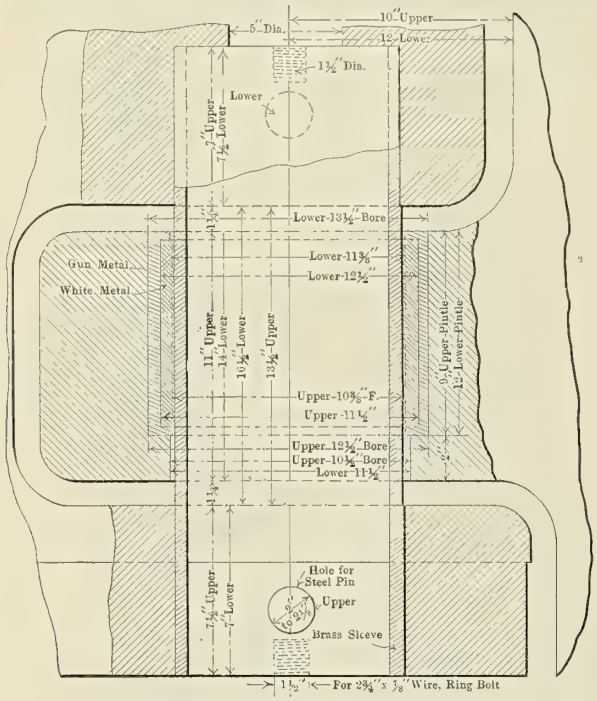
Belt around Skagen, to the North Sea and back through the North Sea-Baltic canal, it being intended to sail towards the Norwegian channel, comprising depths of up to 800 meters (437 fathoms), in order there to test the sounding and water-raising outfits.

The propelling machinery includes two three-cylinder triple-expansion engines of an aggregate output of 350 indicated horsepower, the speed obtained by the vessel being 10½ knots.

A FEW CONSTRUCTIVE DETAILS.

RUDDER STOCKS AND PINTLES.

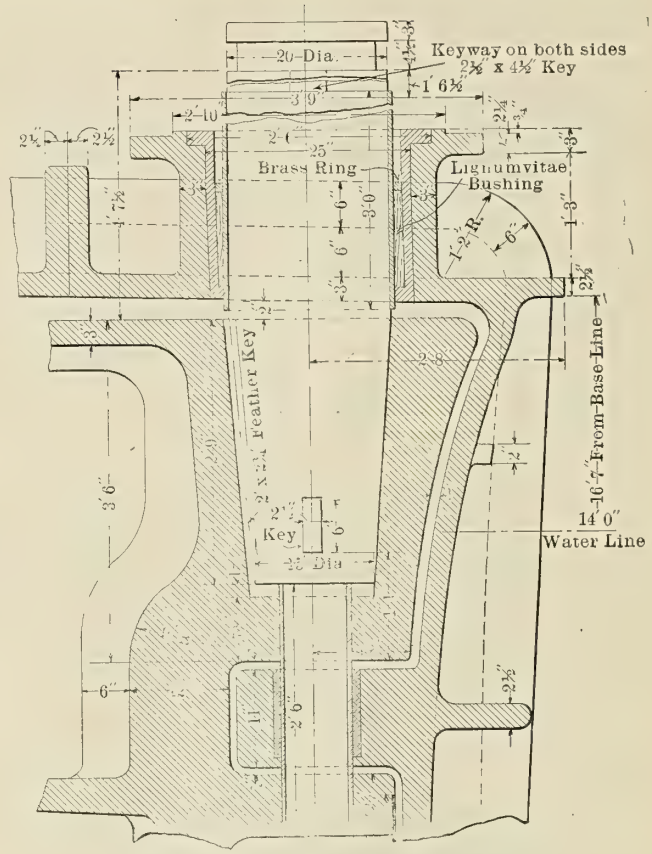
A view is given of the upper and lower rudder pintles of the battleship *Ohio*, the drawing being that made for the upper pintle. The pintles are of wrought steel, and in the rudder frame run in a gunmetal bushing lined with white metal in eleven sections 5/8 inch apart at the inside edge and dovetailed into the bushing. The pintle itself has a diameter of 9 inches upper and 10 inches lower, and is fitted with a brass sleeve having a diameter in the bushing of 10 inches upper and 11 inches lower. The upper and lower diameters



RUDDER PINTLES FOR BATTLESHIP OHIO.

of the sleeve in the upper part of the pintle are respectively 9⅞ and 11⅛ inches. In the lower part of the pintle, the upper and lower diameters of the sleeve are respectively 10⅛ and 10⅞ inches. The total height or length of the upper pintle is 28 inches; of the lower, 31 inches. Both are finished all over.

The rudder stock for the armored cruiser *California* has a net diameter of 20 inches, and is made of wrought iron finished all over. The brass sleeve through the watertight gland is 21 inches in diameter and 3 feet long. It is shrunk on to the stock. The lower end of the stock is tapered from the normal 20-inch diameter to a diameter of 15 inches at the bottom. This taper covers a length of 2 feet 9 inches. A keyway fitted the length of the taper takes a key measuring 2 by 2¾ inches, which is arranged for rigidly fastening the stock to the rudder frame. The brass sleeve runs in a lignum vitae bushing fitted in the brass-lined gland above mentioned. The upper pintle of this rudder is given in the same drawing as the rudder stock, and is seen to have a net diameter of 8 inches and a diameter of 9 inches over the brass sleeve, which is shrunk on. The length of the pintle is 2 feet 6 inches. In

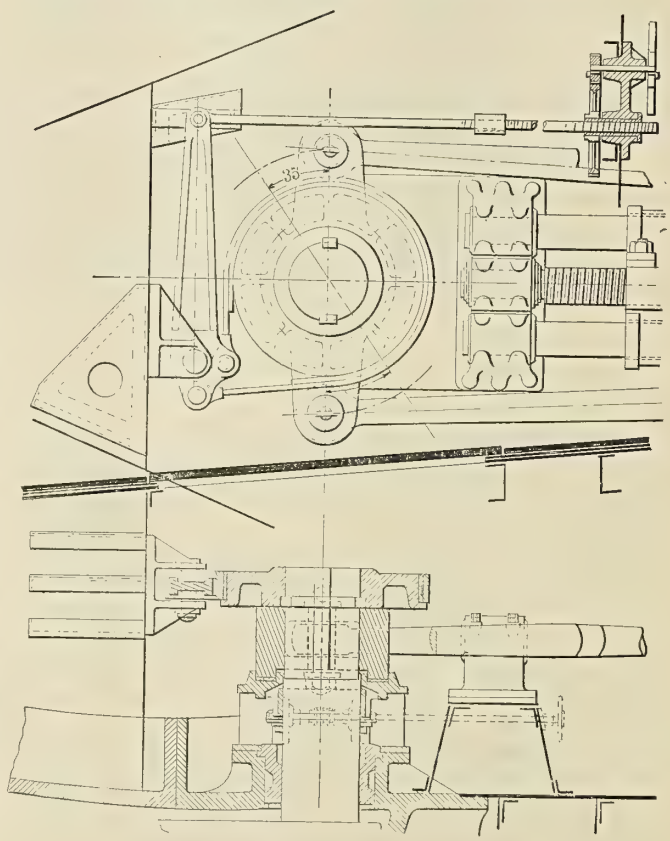


RUDDER STOCK ON ARMORED CRUISER CALIFORNIA.

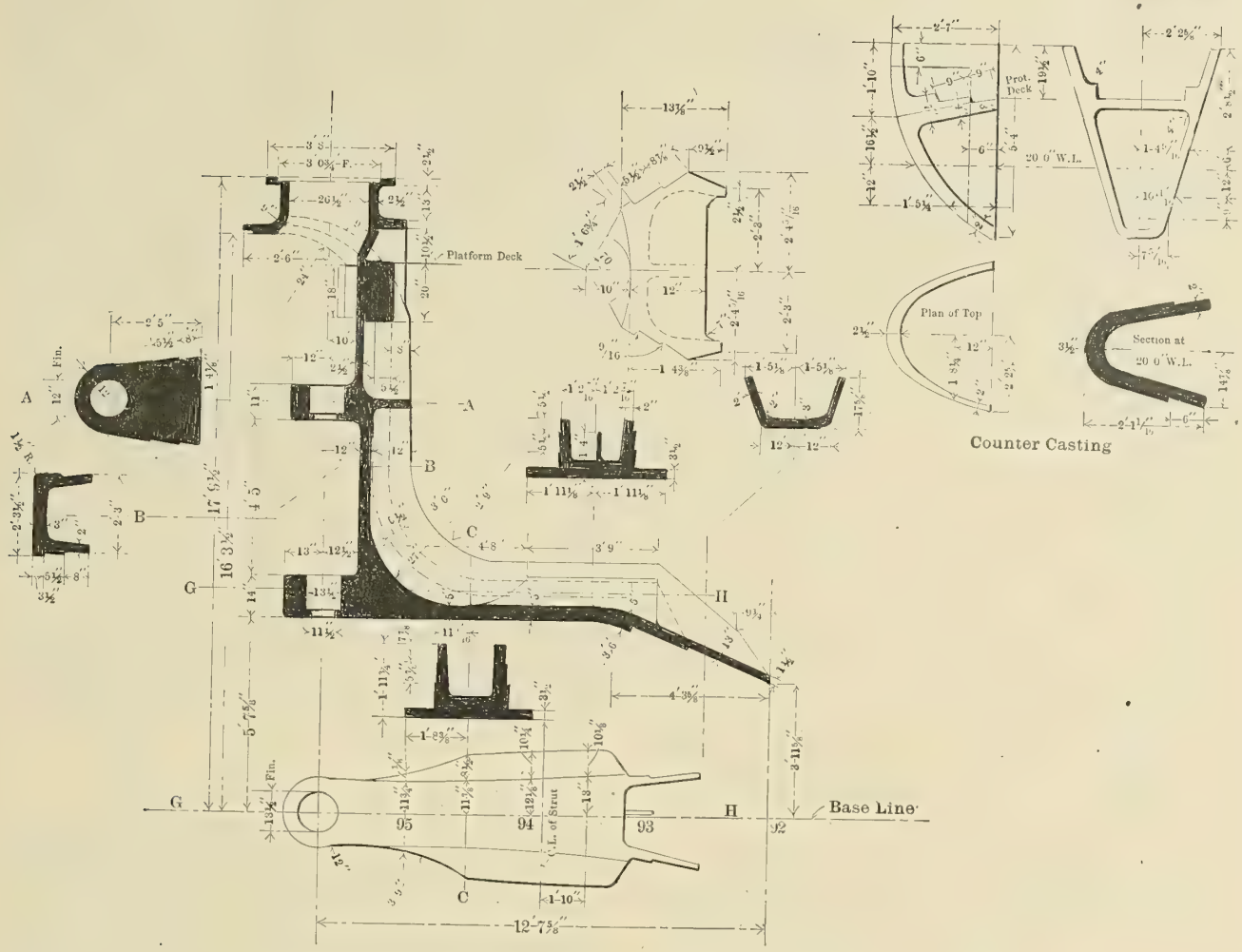
the cast steel stern frame this pintle turns within a white metal bushing of a maximum diameter of 11 inches.

STEERING GEAR FRICTION BRAKE.

The drawing shows the location of the rudder head below



FRICTION-BRAKE DETAILS FOR STEERING GEAR.



DETAILS OF THE CAST-STEEL STERN POST AND COUNTER CASTING ON THE BATTLESHIP OHIO.

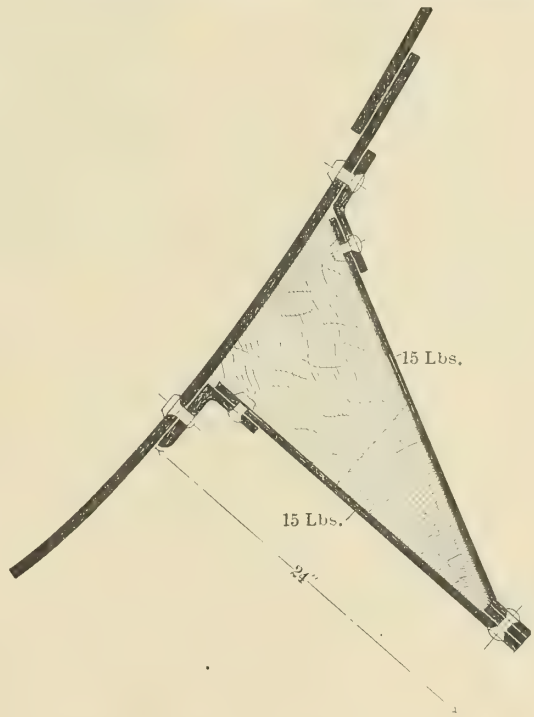
the protective deck of a naval vessel, this being a standard type for large warships in the United States navy. The friction brake is of the ordinary strap or band variety, and is in contact with a friction wheel on the rudder head over a total of 235 degrees. The brake is operated on the usual lever basis, with a long lever arm for the application of the power, and short lever arms for the tightening of the band around the friction wheel. The friction wheel and the lever arm are of cast steel. The feather keys, the friction band, and the friction band lever shaft are of wrought steel. The friction band is lined with wood; the gears and head wheel are of gunmetal; the gear bearing and the lever bracket may be made at will of cast steel or brass.

STERN POST AND COUNTER CASTING.

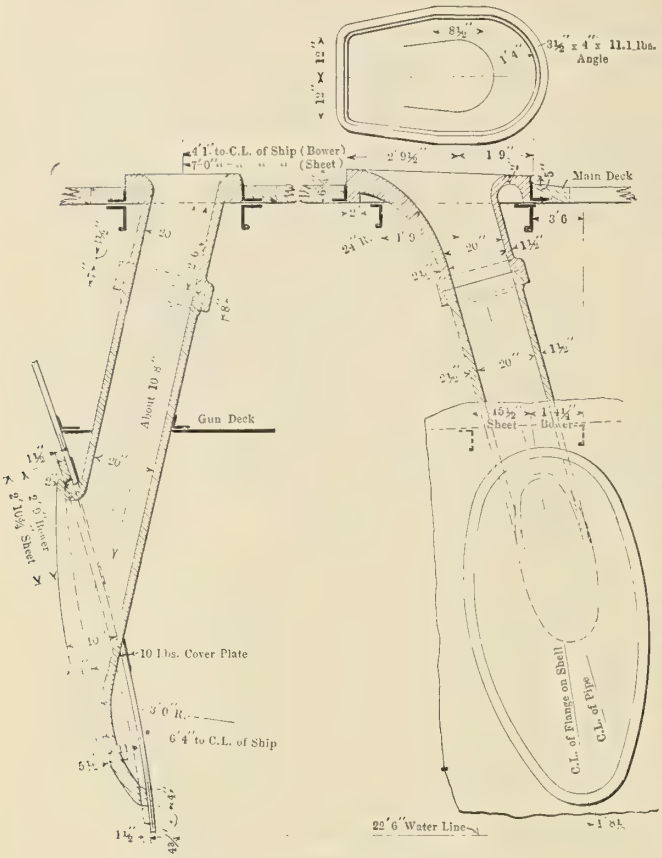
The drawing represents details from the battleship *Ohio*, the weight of the stern post being 23,052 pounds, and of the counter casting 3,900 pounds. The drawing gives all the necessary details.

BILGE KEEL OF THE CRUISER MILWAUKEE.

The drawing shows this bilge keel, which projects 24 inches from the skin plating of the ship, and is made up of two 15-pound plates, with a flat bar at the outer edge, measuring 3 by ¾ inches. Between the two plates is a filling of Oregon pine, the plates being fastened to the ship by angles measuring 4 by 4 inches by 12.8 pounds. Connection between the angles and the plates is by ¾-inch rivets, and between the angles and the shell plating are ⅞-inch rivets, the spacing in each case being 3¾ inches center to center. The outer bar is connected to the plates by ¾-inch rivets spaced 3 inches between centers. Canvas and red lead are placed between angles and the shell plating of the ship. The outer lower

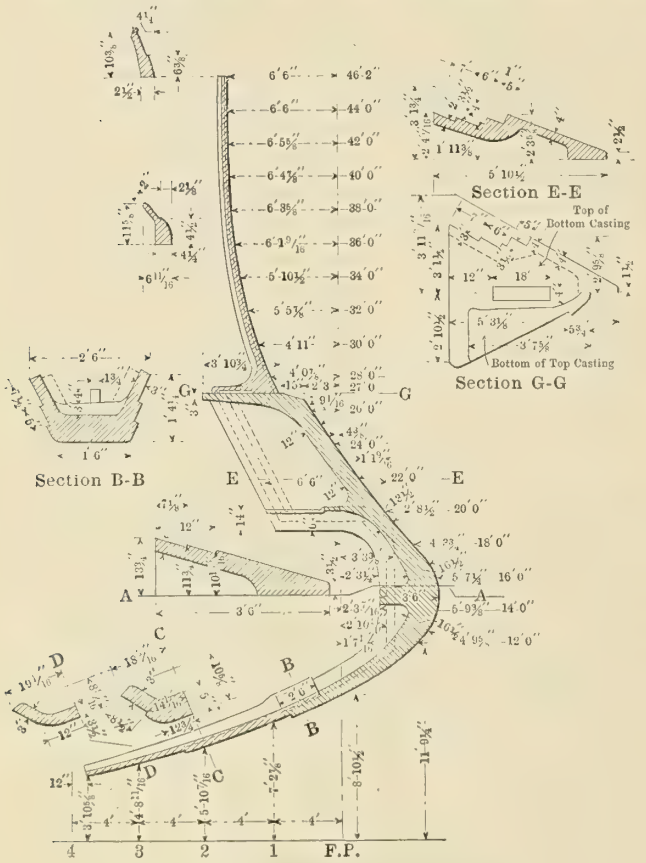


BILGE KEEL SECTION ON CRUISER MILWAUKEE.



HAWSE PIPES OF SEMI-ARMORED CRUISER MILWAUKEE.

point of the bilge keel amidships is 3 feet 2½ inches above the bottom of the keel, and 3 feet 11¼ inches inside the molded line of the frames at waterline. The lower plate prolonged to this molded line intersects it at a point 5 11/16 inches above the bottom of the keel.



STEM AND RAM CASTINGS OF BATTLESHIP OHIO.

HAWSE PIPES OF THE CRUISER MILWAUKEE.

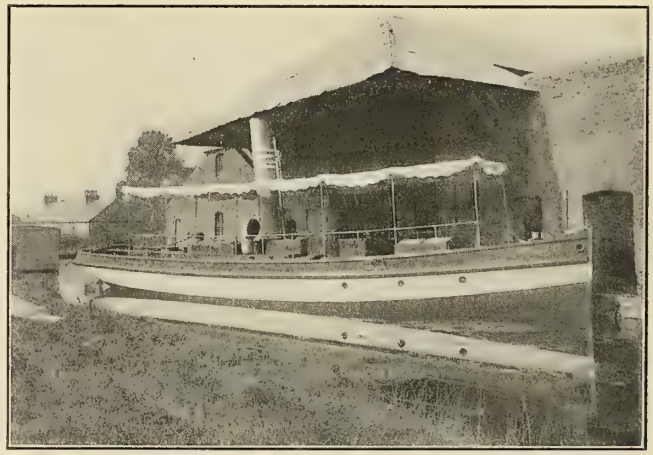
The drawing shows the cast-steel hawse pipes for bower and sheet anchors, they being used with 2½-inch stud link chain. The pipes are of cast steel, in two pieces each, the upper section weighing 3,397 pounds for bower anchors and 3,469 pounds for sheet anchors. The lower sections weigh 9,791 pounds for bower anchors and 10,205 pounds for sheet anchors. Detailed dimensions, etc., are shown on the drawing.

STEM OF THE BATTLESHIP OHIO.

The stem of this battleship is made up of three steel castings, with offsets and dimensions as shown on the drawing. The total weight is 54,630 pounds, of which the middle casting, weighing 40,250 pounds, accounts for by far the larger portion. The upper casting weighs 6,230 pounds, and the lower, 8,150 pounds. The forward perpendicular of this ship is located on the 23-foot 6-inch waterline. The depth of the casting at this point is 14 feet 7½ inches, this being the draft on the forward perpendicular. The lower edge of the casting on this perpendicular is 8 feet 10½ inches above the base line of the ship. The forward point of the ram is 5 feet 9 7/16 inches forward of this perpendicular, the thickness of the casting and rib at this point being 3 feet 6 inches. The casting proper has a fore-and-aft thickness of 16½ inches, with section as shown.

The Steam Towing Launch Lautaro.

This vessel has a length of 55 feet 6 inches, a beam of 10 feet 9 inches, and a draft of 4 feet. She was designed and constructed by Edward Hayes, Watling Works, Stony Stratford, for work in Chile in connection with the customs duty. The hull is built of special mild steel in four strakes, varying in thickness from ¼ to 3/16 inch. The frames are of angle



THE CHILEAN CUSTOMS LAUNCH LAUTARO.

steel. Three bulkheads divide the hull into four compartments. Forward of the collision bulkhead the space is given up to anchor-chain locker. The next section is the saloon, next is the machinery space, aft is a cabin for the crew.

The saloon has seats upholstered in blue with teak edgings, a large folding teak table, lockers, cupboards, brass scuttle lights, a large skylight of teak finished with green figured glass and brass protection rods, and is supplied with a small steam-heated copper water boiler for use in preparing coffee. Aft of the saloon is a lavatory, on the port side, and on the starboard a stairway leading through a teak companionway to the deck.

In the machinery space is a boiler of the marine return tube type, working under a pressure of 120 pounds per square inch, and a compound surface condensing engine for operating the propeller. Cold air is brought to the furnace by two large cowls, a teak engine-room skylight and steel stokehold grating. Hot air is extracted from over the boiler through a steel casing arranged for natural ventilation.

The propelling engine is of the double-balanced crank type, with cylinders 8 and 16 inches in diameter, and a stroke of 10 inches. All wearing surfaces are extra large and automatically lubricated, and the engine is designed for continuous hard work at full speed. The condenser has a large cooling surface, due to the fact that the circulating water available will be of relatively high temperature. The air, circulating, bilge and feed pumps are fitted on the port side of the engine, and worked from the low-pressure cylinder by long, rocking levers. It is said that the engine works very smoothly, and with little vibration.

The shafting is in two pieces, of Siemens-Martin mild steel, with solid couplings. The thrust bearing has seven rings, and is of the horseshoe type, running in oil bath. Plummer blocks are also fitted. The stern tube is lined with white metal for long distances at both ends, and fitted with an internal brass gland. The propeller is of hard cast iron, with three blades. A powerful fire and salvage pump is fitted in the engine room, with deck connections for suction and delivery hose. A supplementary steam boiler feed pump is also fitted in the engine room, as well as a steam ejector.

The cabin for the crew is fitted with seats suitable for bunks, a table, lockers, and a cooking apparatus heated with steam from the main boiler. A canvas awning extends almost the whole length of the vessel, being supported by galvanized hand rail and stanchions. There is a powerful patent slip hook with disconnecting gear, towing bits, a large teak shelter for the customs officers, and a steering wheel of brass-bound teak on weather-proof standard. A small winch is fitted forforward for raising the folding anchor.

Horsepower of Auxiliary Machinery.

The Editor INTERNATIONAL MARINE ENGINEERING:

Some years ago I had occasion to work out the relative power developed by main and auxiliary engines, in order to keep separate accounts of power developed, and steam and coal used, of main and auxiliary machinery. The result, I think, is a fair average for transatlantic liners under ordinary working conditions. Owing to the great variation in speed and fluctuations of load, it is practically impossible to obtain an absolutely correct average of the power developed by some auxiliaries, since most of them, especially the pumps, are not fitted with indicator attachments, and the mean effective pressures in the cylinders must be assumed. In some of these cases it is more accurate to calculate the work done and power developed (in the pumps) by the displacement of the water piston and the pressure heads against which water is delivered, due allowance being made for friction and pump efficiency. With the electric plant the power developed can be determined from the current output in amperes and the potential, due allowance here being made for friction of engine.

In the test in question the twin-screw propelling engines developed 20,446 indicated horsepower. This included the air pumps, which were attached to the main engines. The principal other auxiliaries to these engines were as follows:

	Horsepower.
12 forced-draft fans for main boilers	652
1 forced-draft fan for donkey boiler	23.6
3 fans for engine-room ventilation	38.7
4 circulating pumps for main condensers	96.5
1 circulating pump for auxiliary condenser	3.3
2 main feed pumps	105.6
2 hot-well pumps	28.2
1 donkey boiler feed pump	4.1
	952

The electric plant included six dynamo engines, as follows:

	Horsepower.
3 for lighting, and ventilating fans in saloons	91.5
2 for ventilating fans in fire rooms	44.7
1 for operating ammonia compressor fans	14.1
	150.3

The other auxiliaries included:

	Horsepower.
2 engines for driving ammonia compressors	28.5
2 hydraulic pumps for steering and working elevators	33.9
3 evaporator feed pumps	2.1
2 bilge pumps	4.8
2 sanitary pumps	3.7
3 fresh-water pumps	1.3
3 brine pumps for refrigerating plant	5.5
2 circulating pumps for refrigerating plant	2.8
1 ballast tank pump	16.3
	98.9

This makes a grand total of 1,201.2 indicated horsepower for auxiliary machinery. Omitting the ballast tank pump, which would be used only very occasionally, we find that the balance of 1,184.9 horsepower is 5.79 percent of the horsepower of the main engines.

During a trip across the Atlantic, the average quantity of South Welsh and Eureka coal consumed per hour for all purposes was estimated at 31,733 pounds, on the basis of the amount on hand at beginning and end of voyage. This represents 1.55 pounds per indicated horsepower per hour as developed by the main engines. The consumption of steam, calculated from indicator diagrams of main engines, was 13.6 pounds per hour per horsepower, to which 20 percent was added for condensation, making 16.3 pounds, or a total of 333,270 pounds of steam per hour.

The steam used by the dynamo engines at 25 pounds per horsepower hour (with 150.3 horsepower) was 3,757 pounds. The fans and circulating engines, 842.6 horsepower at 35 pounds per unit, used 29,491 pounds of steam. The pumps, 192 horsepower at 85 pounds per unit, used 16,320 pounds of steam. The evaporators, in making up feed water, used 14,880 pounds of steam. This makes a total of 64,448 pounds of steam, or 8,056 pounds of coal on the basis of 8 pounds of steam per pound of coal. Deducting this from the total coal consumption per hour, we have 23,677 pounds for the main engines, or only 1.158 pounds per indicated horsepower per hour.

H. J. TEIPER.

A Patent Oil Firing System.

BY A. K. FISHER.

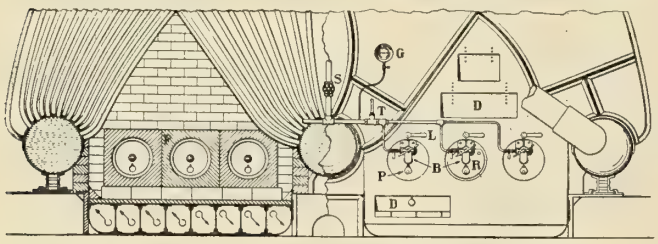
The great success attending the trials of the British destroyers of the *Mohawk* class has attracted attention to the subject of oil fuel, which is understood to have been largely responsible for the extreme power and speed developed by these vessels. The development of oil firing on steamships seems to have entirely demonstrated the superiority of the mechanical burner as compared with systems using steam or compressed air for atomizing liquid fuel. The system

(Koerting) under consideration, however, adds to the mechanical feature the physical effect of atomizing. This gives a still better result in service. The inventor is Ernest Koerting, Hanover, Germany.

The handling of the oil for taking it on board, storing and transferring it from the various tanks is taken care of by an independent pumping and piping system. This arrangement provides proper pumps to handle the oil with a pipe system as simple as possible through manifold arrangement, and to supply the oil to the settling tanks.

From the settling or service tanks the oil is supplied to the burners; the main object of these settling tanks is to separate the oil from water which it may hold in suspension. The tanks are equipped with diaphragms to prevent the water, after being separated, from again mixing with the oil in consequence of the motion of the steamer. The oil is taken from the settling tanks at a distance of one-fourth of the height of the tank from the bottom, so as not to take in the water and impurities; cocks being provided on the bottom of the service tank to drain off the water.

The suction heaters are usually placed in the settling tank, which consists of a steam coil of proper size surrounding or near the suction pipe. The oil is now drawn through the suction filter by pump, and forced through pressure filter, pressure heaters and to the Koerting burners in front of the boiler. The temperature of the oil when leaving the suction heater will be from 90 to 100 degrees F., and in the pressure heater



BOILER ARRANGED FOR EXCLUSIVE OIL FIRING.

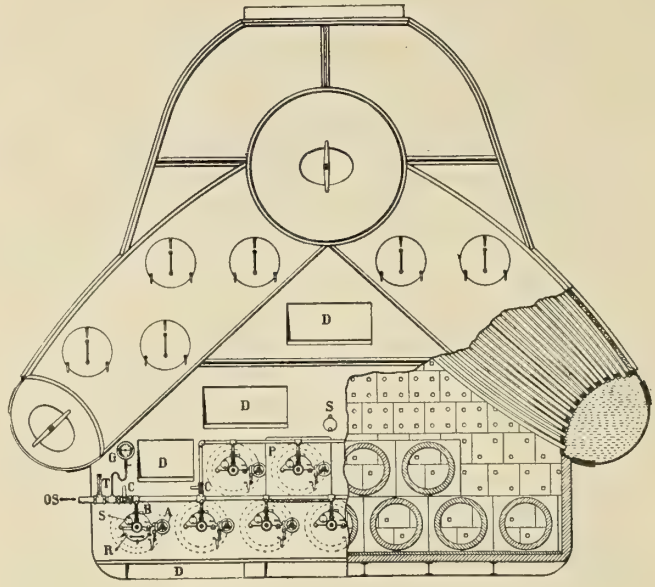
it is heated up to 260 degrees F. Evaporation is prevented by having the oil under a higher pressure than corresponds to the above-named temperature.

The central outfit is usually combined in one place in each boiler room, for reasons of simplicity of piping. The pump may be either of the horizontal or vertical type, according to conditions. The heaters are placed either vertically or horizontally, but always with a view of having easy access to the piping. The piping arrangement inside the central outfit gives the possibility to use either of the duplex filters, heaters or pumps, according to convenience and necessity.

The piping system contains also other appliances for safety and measuring, that is, safety valve to act in case of excess of pressure in the oil line; gages to indicate the pressure of steam and oil; and thermometer to show the temperature. The steam pressure in the steam pumps and in the heaters is kept constant by one main reducing valve.

The Koerting burners are arranged in front of the boiler, as shown by cut; each burner spraying usually 300 to 400 pounds of oil per hour at 100 pounds pressure. The burners are fastened to the front plate of the boiler by means of a sliding door, which admits of removing the burner for cleaning or replacing.

To burn one pound of oil, there is required 200 cubic feet of air, and this air is admitted to the burner by means of a cylindrical air register, which permits of an exact regulation of the quantity of air required for combustion. The air registers are sometimes, if space permits, arranged with blades to give the air a rotary motion to assist the proper mixing of oil and air.

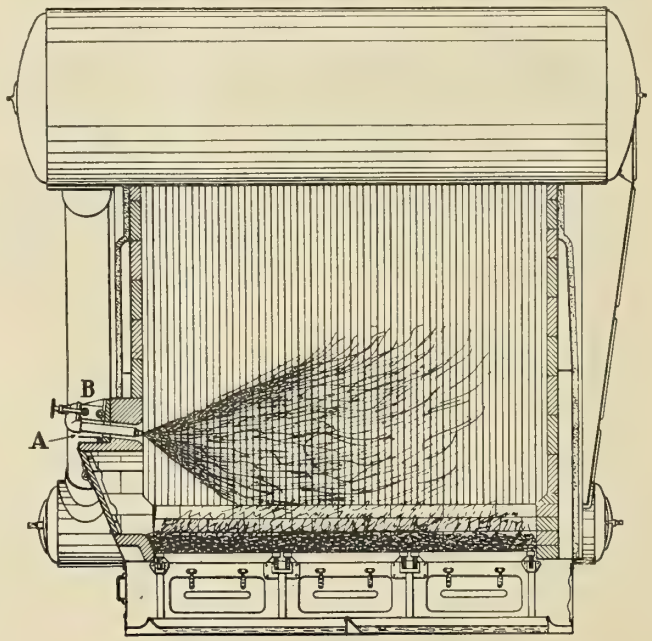


BOILER ARRANGED FOR EXCLUSIVE OIL FIRING.

To further compel the air requisite for combustion to intimately mix with the oil, fire-brick cylinders are installed. This arrangement forces the air to surround the injected oil and to reach a proper contact between air and the fuel for combustion. This network of fire-clay acts also as a heat accumulator, and helps to keep the furnace at a high temperature. Where no donkey boilers are installed, some of the burners on each boiler are equipped with a heating coil to heat oil in starting up, and a hand pump is furnished for keeping up oil pressure until enough steam is available for running service pumps.

The system is used in two ways, the first of which is known as "exclusive" oil firing, where nothing but oil is used as fuel; while in "additional" oil firing, oil is used to supplement the burning of coal, and is particularly available for getting up steam rapidly, or for high forcing where the coal used would give merely a normal operation. The types of apparatus are naturally quite different in these two cases.

The cut showing the application of the system for exclusive oil firing gives the arrangement as fitted to a watertube boiler



BOILER ARRANGED FOR ADDITIONAL OIL FIRING.

of the Thornycroft, Schultz, Yarrow, Mosher, Normand or White-Forster type. In the illustration, six burners are fitted at *B*, air entrance being provided below and above them at *D*. Each burner is located in a fire-brick cylinder *F*, and is equipped with an eyeglass *P*, for observing the action, and air register *R*. The handle *L* is designed for regulating the entrance of air. Oil supply is furnished through the pipe *S*, and a gage at *G* and thermometer at *T* are used for observing the pressure and temperature under which the oil is fed. (In the larger cut, the oil supply is at *OS;* the observation holes at *S;* the hand wheels for regulating air supply at *A;* and the cocks for regulating oil supply at *C*.)

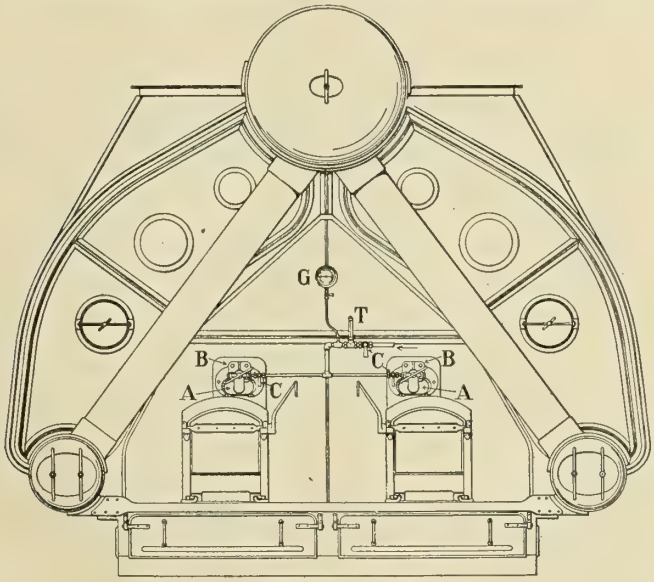
The drawing is from an installation on a British torpedo boat, and may be compared with other similar installations in the following table, where *A* represents the torpedo boat in question, *T* represents the *Tartar* of the British navy, *M* is the *Mohawk* (the *Cossack* is similar) and *S* is a German torpedo boat of the *"S"* type.

	A	*T*	*M*	*S*
Heating surface (*a*) (*b*).....	4,478	5,300	4,931	6,350
Number of burners (*a*).....	12	14	13	16
Heating surface (*b*) (*c*).....	373	378	379	397
Pounds of oil (*c*) (*d*).....	400	325	320	401
Pounds of oil (*e*).....	1.07	0.86	0.845	1.01

(*a*), per boiler; (*b*), square feet; (*c*), per burner; (*d*) per hour; (*e*), per square foot of heating surface per hour.

For "additional" oil firing the burners *B* are installed above the grate, and are so arranged as not to prevent the feeding of coal. In some cases they are placed between the fire doors, instead of above. As the space is usually limited, the construction of the burner and air register is often combined, and the regulation of air accomplished by means of flaps. The air register is at *A*, the supply of oil being regulated by the cock at *C*.

Under natural draft the *Segovia*, belonging to the Hamburg-American Line, which has engines of 2,200 horsepower and a heating surface of 7,560 square feet, consumes 32 tons of oil per day, as compared with 45 tons of coal for the same work before the oil burners were fitted. The saving in weight



BOILER ARRANGED FOR ADDITIONAL OIL FIRING.

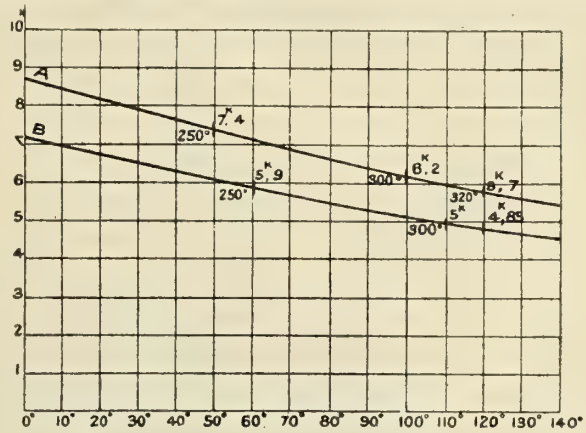
of fuel is seen to be about 30 percent. In the *Sithonia* and *Silvia*, of the same line, operated with Howden's heated air system, with 7,000 square feet of heating surface, the previous consumption of 42 tons of coal per day has been reduced to 27 tons of oil. This shows a saving of about 35 percent. A still greater saving is shown by the Austrian-Lloyd steamer *Almissa*, with 900 horsepower and 2,760 square feet of heating surface. The saving here is shown to be about 47 percent, so far as weight of fuel is concerned.

NOTE ON THE USE OF SUPERHEATED STEAM WITH MARINE ENGINES.*

BY FELIX F. T. GODARD.

Superheated steam was used in marine engines more than half a century ago, after Hirn's noteworthy experiments with the "Logelbach's" engine in Alsace. The French navy also tried it on some of their earliest protected cruisers. These early attempts were not, however, followed up, as it was found difficult to construct superheaters capable of maintaining a constant and sufficiently high temperature, and also because of the wear and tear of the hemp packings in use at that period.

The introduction of compound marine engines, more economical than the simple engines that had preceded them, caused the use of superheated steam to be given up for the



STEAM CONSUMPTION IN KILOGRAMS PER BRAKE HORSEPOWER, BASED ON SUPERHEAT, IN DEGREES CENTIGRADE.

time being. The same thing occurred with stationary engines, where improvements in valve gear enabled a high ratio of expansion to be employed, and the clearances to be reduced to a very small percentage of the cylinder volume.

In the Vosges and Alsace, however, the problem of using superheated steam in stationary engines was revived some fifteen years ago. Several different arrangements were designed by Mr. E. Schwoerer, a former assistant of Hirn, who used a massive superheater placed behind the fire bridge of the boiler furnace, and this gave such promising results that the study of the question of superheated steam was taken up by a number of manufacturers, chiefly in Germany, Alsace and Switzerland. It was found that engines fitted with Sulzer Colman valves, which were largely employed in those countries, were very suitable for use with superheated steam. In France, where the Corliss gear was usual in stationary engines, superheating did not make much progress, because it was not suited to the Corliss engine, or, in fact, to any flat slide-valve engine. The exhibits at the Paris Exhibition of 1900 showed this to be the case.

Since then, the use of superheated steam with stationary engines has increased largely, and considerable economy has been effected thereby. It is not unusual to find engines of 1,500 to 2,000 horsepower using steam at 300 degrees C. (572 degrees F.), and working at an expenditure of only 4 kilograms (9 pounds) of steam per indicated horsepower† per hour. There is but little information, however, on the subject of the variation in the consumption of steam in relation to its temperature.

A few years ago the author made some experiments on a triple expansion engine with piston valves, the temperature of the superheated steam varying from 0 to 120 degrees C. The results of these trials still present some features of interest. In the diagram (Fig. 1) the abscissæ represent the

* Read before the Institution of Naval Architects, April 9, 1908.

† Indicated horsepower referred to in this paper is the French "force de cheval" of 75 kilogram-meters per second = 0.986 British indicated horsepower.

amount of superheat, *i. e.*, the difference between the actual temperature of the steam (in degrees C.) and the temperature corresponding to the pressure when the steam is saturated. The ordinates represent the weight of steam consumed per effective brake horsepower.

This engine had cylinders 20, 33, 37 and 37 centimeters (7⅞, 13, 14½ and 14½ inches) in diameter, with a stroke of 29 centimeters (11½ inches). At 440 revolutions per minute the brake horsepower was 300. The cut-off of 0.7 gave a ratio of expansion of 9.8. The pressure in main steam pipe (exhaust at atmosphere) was 12.8 kilograms (182 pounds) per square inch; at exhaust of condenser it was 15 kilograms (214 pounds) per square inch.

Now, curve *A* in the diagram (Fig. 1) (exhaust to atmosphere) shows that the consumption per hour of saturated steam (*i. e.*, with no superheat) is 8.85 kilograms (19½ pounds) per brake horsepower, whereas it falls to 5.7 kilograms (12¾ pounds) at a temperature of 320 degrees C. (608 degrees F.), equivalent to a superheat of 120 degrees C. (216 degrees F.).

The saving therefore amounts to

$$\frac{8.85 - 5.70}{8.85} = 35.5 \text{ percent.}$$

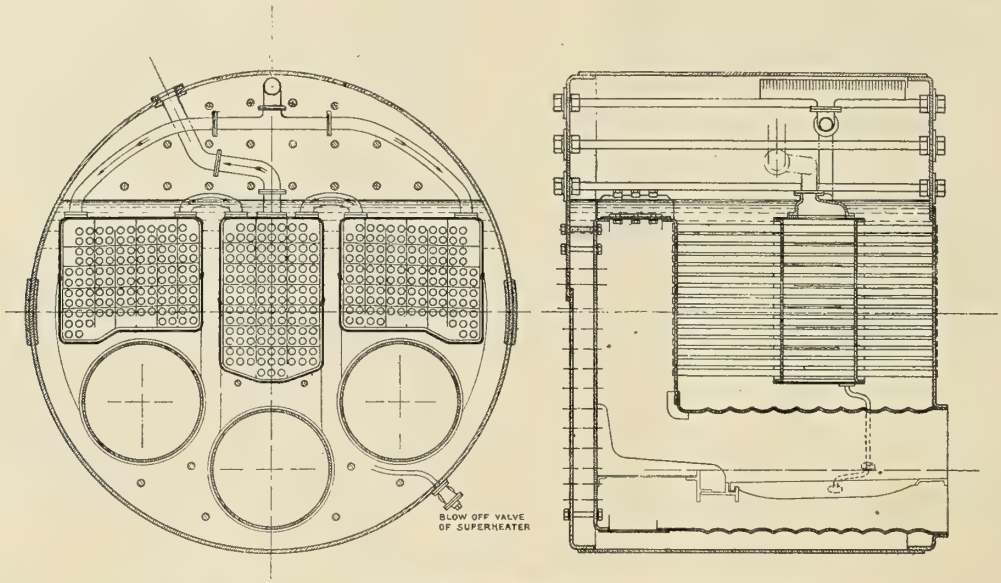
Taking curve *B* (exhaust to condenser), the consumption per brake horsepower falls from 7.15 kilograms (16 pounds) with no superheat to 4.85 kilograms (10½ pounds) with a superheat of 120 degrees C., or a saving of

$$\frac{7.15 - 4.85}{7.15} = 32 \text{ percent.}$$

It will be seen, therefore, that superheating may lead to an economy, as compared with saturated steam, of 35 percent in engines of this type exhausting to the atmosphere, and 32 percent for those exhausting to the condenser. The amount of reduction in steam consumption depends, of course, upon the design of the engine under consideration; in the present case it amounts to about 1 percent for every 4 degrees C. (7.2 degrees F.) of superheat. This is a figure frequently given, and which the author has been able to verify elsewhere.

Doubts, however, have often been expressed in regard to the efficiency of superheating in actual practice. These arise from the wear of the valve gear of the engines, which causes losses that neutralize part of the economy obtained by using superheated steam. It is now recognized by all the makers of land engines that, in order to use steam at a temperature of 280 degrees to 320 degrees C. (536 degrees to 608 degrees F.), the engine friction must be as small as possible, as, for instance, in reciprocating engines with lift valves, and still more so in turbine engines. Superheated steam is now generally adopted for land engines by reason of the economical results obtained in practice, which, in certain special cases, have effected a saving of upwards of 33 percent.

For marine engines the case is very different. England was the first country to take up the matter; in 1900, Messrs. Wilson & Sons, of Hull, installed superheaters on board the steamship *Claro,* which appear to have given satisfactory results. Other installations followed with varying measures of success. The Admiralty investigated the question on the battleship *Britannia,* with satisfactory results. Superheating has also been adopted in the United States on the steamship *Creole,* fitted with Curtis turbines, and in Germany on the *Ersatz Komet,* with Parsons turbines. Nevertheless, superheating in marine engines cannot be said to have gained ground as rapidly as was expected. It may, therefore, be of interest to record some very encouraging results which have been obtained in France within these last few years.



CYLINDRICAL BOILER OF STEAMSHIP PEROU, FITTED WITH PIELOCK SUPERHEATER.

In 1906 the Société de Saint-Nazaire built two identical cargo boats for the Compagnie Générale Transatlantique. They were the *Garonne,*‡ fitted with ordinary triple expansion engines and slide valves, and the *Rance*‡ with similar engines, but fitted with the Lentz valve gear. The boilers of the latter vessel are similar to those of the former, except that they are fitted with Pielock superheaters.

The leading dimensions of these two ships, their engines and boilers are as follows:

Length	91. meters (298 feet 6 inches)
Beam	12.2 meters (40 feet)
Molded depth	7.75 meters (25 feet 5 inches)
Load draft	6.4 meters (21 feet)
Gross tonnage	2,700 tons.
Diameter of cylinders	584, 914 and 1,498 millimeters.
Diameter of cylinders	23, 36 and 59 inches.
Stroke	1,066 millimeters (42 inches.)

The boiler installation of each ship consists of two cylindrical boilers, each having two furnaces and fitted with Howden's forced draft. In each case the grate area is 8.4 square meters (90.42 square feet), and the total heating surface 350.08 square meters (3,767 square feet). In the case of the *Garonne* this was all ordinary heating surface. In *La Rance,* however, 73

‡ International Marine Engineering, page 371, September, 1907.

square meters (785 square feet) of the amount was superheating surface.

The trials of these two vessels were carried out under conditions as similar as possible, so that the comparison of results might be quite fair, and the coal used was the same in both cases. The results of the trials were as follows:

	Garonne.	*Rance.*
Date of trials	July 6, 1906.	September 13, 1906.
Boiler pressure	12.60 kg. (178 lbs.)	12.54 kg. (177 lbs.)
Steam temperature	192°C. (377.6° *Fahr.*)	270° C. (518° *Fahr.*)
Revolutions	72.3	75.37
I. H. P.	1,104	1,304
Coal consumption—per I. H. P.	511 grams (1.12 lbs.)	408 grams (0.9 lb.)
Advantage of superheating:		
Increase of power		18.1 percent.
Reduction of coal consumption		20.1 percent.

Both ships were put into service directly after the trials. It is now over a year since these two cargo boats have been engaged upon an exactly similar service, and it has been possible, therefore, to obtain accurate data regarding their working and comparative coal consumption. Taking for each ship ten trips made at corresponding dates, so as to have as far as possible identical conditions of weather, loading and quality of coal used, the fuel consumption per mile worked out at 69.981 kilograms (154 pounds) for the *Garonne* without superheating; 57.228 kilograms (126 pounds) for the *Rance* with superheating.

Comparing these figures, we have an economy in coal consumption in favor of the *Rance* of

$$\frac{69.981 - 57.228}{69.981} = 18.2 \text{ percent.}$$

There was, moreover, no trouble with either engines or boilers. No leakage has occurred in the valves, which continue to bear simultaneously on both upper and lower seatings. The superheater has not required any particular attention; a constant steam temperature has been maintained, which rises only a few degrees when additional power is required of the boilers, and falls again automatically directly the engines are stopped.

In consequence of the results of the early trials of the *Rance,* the Compagnie Générale Transatlantique installed Pielock superheaters and Lentz valve gears on the steamship *Pérou,*§ for service to the Antilles (West Indies), and also on the intermediate cargo boat *Caroline.* The same arrangement is being adopted on the cargo boat *Honduras,* and other cases are under consideration. Each of these vessels is to be comparable to a sister ship, working with saturated steam, in order to follow up on a larger scale the conclusive results already obtained with the *Rance* and the *Garonne.*

The *Pérou* has just completed her trials. She is identical, save for the superheating and valve gear, with the steamship *Guadeloupe*§ employed on the same service, and which was completed in September, 1907.

The dimensions of these two ships are as follows:

Length	131. meters (429 feet 9 inches)
Beam	15.86 meters (52 feet)
Molded depth	10.5 meters (34 feet 6 inches)
Load draft	6.6 meters (21 feet 7 inches)
Gross tonnage	6,800 tons.

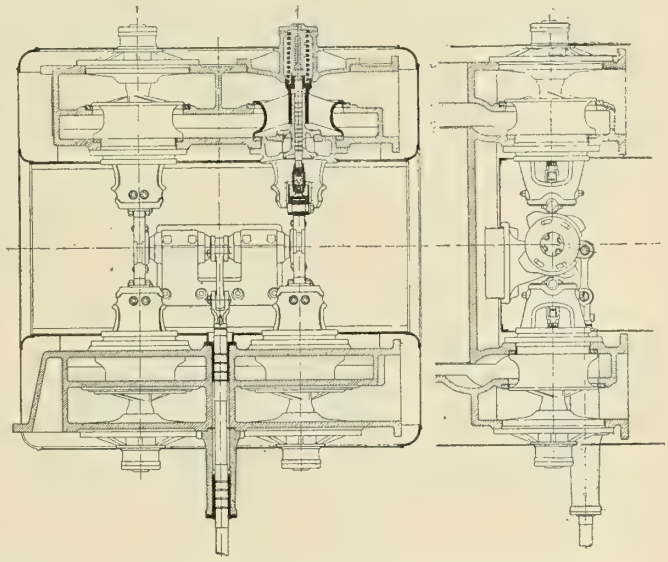
The illustrations give the details of the valve gear and a section of the boiler and superheater.

Each vessel is fitted with twin-screw triple expansion three-cylinder engines of the following dimensions:

§ INTERNATIONAL MARINE ENGINEERING, page 373, September, 1907, and page 44, January, 1908.

	Guadeloupe.	*Pérou.*
Diam. of cylinder (H.P.)	0.685 m. (27 in.)	0.685 m. (27 in.)
Diam. of cylinder (M.P.)	1.092 m. (43 in.)	1.060 m. (41¾ in.)
Diam. of cylinder (L.P.)	1.828 m. (72 in.)	1.828 m. (72 in.)
Stroke	1.219 m. (48 in.)	1.219 m. (48 in.)

The boiler installation of each ship comprises six cylindrical boilers having three furnaces each, and fitted with Howden's forced draft. The working pressure is 13 kilograms (185 pounds) per square inch. In each case the grate area is 32.13 square meters (346 square feet). The *Guadeloupe* has ordinary heating surface of 1,255 square meters (13,509 square feet); while the *Pérou* has 932.7 square meters (10,030 square feet) of ordinary heating surface and 302 square meters (3,260 square feet) of superheating surface; a total of 1,234.7 square meters (13,290 square feet).



VALVE GEAR OF LOW-PRESSURE CYLINDER ON PEROU.

The speed trials of both vessels, which were carried out under absolutely similar weather conditions, gave the following results:

	Guadeloupe.	*Pérou.*
Date of trials	September 9, 1907.	February 6, 1908.
Boiler pressure	13 kgms. (185 lbs.)	13 kgms. (185 lbs.)
Temperature of steam at engines	192° C. (377.6° *Fahr.*)	238° C. (460° *Fahr.*)
Revolutions	88.19	88.47
I. H. P.	6,585	6,750
Speed	16.60 knots.	16.95 knots.

These results were considered most satisfactory, both by the Postal Commission and by the owners of the vessels.

A noteworthy feature is the constant temperature of the superheated steam. This temperature was taken at admission of steam to the engines by means of a Fournier recording thermometer. The diagrams obtained representing the temperatures of the steam, both during firing of the boilers before the trials, during the trials, and also while slowing down, and those taken during the first voyage in service show that the variations of temperature are very small, and do not exceed 20 degrees C. (36 degrees F.) from the time of starting the engines to that of running at full power, which includes also the period of cleaning the fires.

These results are very interesting, as being applicable also to the use of superheated steam in large turbines on board ship. The absence of sudden changes of steam temperature in turbine engines will prevent the apparatus from being exposed to sudden expansion and contraction, the effects of which might be serious.

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Naval Disasters.

The month of April of 1908 has been unusually prolific in disasters of a serious nature affecting warships. Strange as it may seem, the four most prominent cases of this sort have all fallen upon the shoulders of the Anglo-Japanese allies. Britain has lost three warships by collision, each vessel being practically cut in two by the colliding ship, while Japan has just lost an old cruiser by an explosion, and more than two hundred of her crew went down with her.

To recapitulate these losses, it is sufficient to state that early in the month the destroyer *Tiger* (383 tons and 30 knots; launched in 1900) was cut completely in two by the armored cruiser *Berwick* (9,800 tons and 23 knots; launched in 1902), and thirty-six lives were lost from the destroyer's crew. The accident occurred at night, during maneuvers.

A few weeks later the American Line steamship *St. Paul* crashed into the cruiser *Gladiator* (5,750 tons and 20 knots; launched in 1896) and damaged her so severely that she sank in 20 minutes, with a loss of twenty-eight men. Scarcely had the echoes of this disaster disappeared than another followed on its heels, when the destroyer *Gala* (570 tons and 26 knots; launched in 1904) was cut in two by the scout *Attentive* (2,670 tons and 26 knots; launched in 1904) and sent to the bottom. In this case only one life was lost.

The Japanese accident occurred early in the morning on the last day of the month, while the ship was at anchor in harbor. An explosion of a magazine in the cruiser *Matsushima* (4,277 tons and 16 knots; launched in 1890) sent the vessel promptly to the bottom with a loss of 207 men, many of whom were cadets, engaged in a practice cruise on this vessel, which was attached to the training squadron. This ship is interesting as having been, in 1894, at the battle of the Yalu, the flagship of Admiral Ito, and as having been instrumental in that memorable fight in the capture of a Chinese armored battleship, although none of the vessels in the Japanese squadron was armored.

All of these accidents may be classed under the general heading of unavoidable. Two of them occurred during maneuvers at night, and may be set down to the natural risks run in operating ships of war during maneuvers, and at all other times; one of them occurred during a heavy fog accompanied by a severe snow storm, and a court of inquiry has exonerated from blame the officers of both vessels; the other occurred by an unforeseeable explosion, such as that which over two years ago destroyed Togo's famous flagship, the *Mikasa,* while the vessel was lying peacefully at anchor in a home harbor. It may also be compared with the disaster which overtook the French battleship *Jéna* a little more than a year ago, while the ship was in dry-dock in the dockyard at Toulon. The *Mikasa* has recently been repaired; the *Jéna* was so seriously damaged as to be a total loss; and it is probable that the *Matsushima,* particularly in view of her age, will not be salved.

Large Steam Yachts.

In our present issue will be found descriptions of three of the largest privately-owned steam yachts afloat, all built during the past year for American owners by British yards. Each of these vessels is a splendid example of naval architecture, and is a decidedly notable addition to the rapidly increasing fleet of steam yachts of the world.

Perhaps the most significant feature of the whole thing is that, although these yachts are built for Americans, they were constructed all in Scotch yards, and two of them were of Scotch design.* The whole proposition appears to have been one where low cost of

* To this list might be added a fourth large steam yacht—the *Cassandra*—launched from a Clyde yard in February, for an American yachtsman, and building from American designs.

production was an important feature, notwithstanding the necessarily great wealth of the individual owners, and, of course, it goes without saying that, so far as cost is concerned, the Scotch yards can compete with any in the world.

Numerous statements have been made from time to time regarding the financial relations between marine construction in the United States and that in Great Britain and on the continent. When it comes to a question of quality there is perhaps little to choose; but the all-governing commercial item of cost militates so strongly against the American yards, as compared with their competitors, as to make it practically out of the question for these yards to obtain any business except that under the protection of the coasting trade laws, which require vessels engaged in that service to be built in American yards.

While it would be idle for us to enter here into a discussion of relative wage scales, yet figures put into our possession two or three years ago, comparing wages in British yards with one of the American yards, are significant. In the case of the British yards the figures show the average of twelve representative plants. There are thirty classes of employees compared in each case, ranging from draftsmen through the pattern, blacksmith, machine, boiler and joiner shop to ship carpenters, fitters, riveters and coppersmiths, with apprentices, helpers and boys under most of the several headings. In only eleven of the thirty cases cited does the American wage fall below *double* the British wage; in only five cases of these eleven is the excess less than 90 percent; in no case is this excess less than 70 percent. Comment is superfluous.

A single example of this sort suffices to show good and sufficient reason why the American merchant marine in the foreign trade, and the American shipyards in general, are in a very precarious position. With a wage scale approximately double that of their competitors: with material costing no less, and in some cases markedly more; with social aspirations and family ties operating in some cases to disparage business ability and technical training, for which they are ostentatiously substituted; with many glaring examples of financial juggling in connection with organization and reorganization *ad infinitum;* it is no wonder that prosperity does not rest upon them. Until some measures are provided amelioriating these conditions, or in some way equalizing the differences existing in comparison with British and continental yards, it were idle to hope for any marked improvement.

Steering Gear.

Our notes in another column, covering steam steering gear, have been prepared for us by four or five different manufacturers in Britain and America. The first successful steam device for the steering of ships appears to have been inaugurated only forty-two years ago. Prior to that time reliance was placed almost entirely upon hand steering, and the burly arms of sometimes as many as four quartermasters were required in heavy weather to keep a ship on her course. With the advent of mechanical means for performing this, one of the most important functions on a large ship, it has become possible to handle the vessel from whatever point of vantage may be most convenient, and the muscular effort required is practically negligible.

A powerful combination of gears fitted for this purpose, and including in most cases worm gears of slow speed and great strength, have made it possible to concentrate in a small space the agency for handling the rudder. As a general proposition, in merchant ships this is placed far above the waterline, many of the largest liners having the gear located in a small deckhouse directly over the rudder head. In most warships, however, and in certain special merchant vessels, such as the *Lusitania* and *Mauretania,* the entire gear is located well below the waterline, and usually below an armored deck as well. Here it is entirely protected from a chance or a deliberate shot, and may be relied upon to do its work silently and efficiently, in accordance with the requirements of the man on the bridge.

Accidents to rudders and steering gear, due largely to the shocks occasioned by impacts upon the rudder of heavy seas, are not infrequent; and as the blows are both sudden and severe, heavy construction is necessary to insure immunity from disablement on this score. With a twin-screw ship the loss of a rudder, or of proper means for controlling it, while sufficiently serious, may yet, by skillful seamanship, be largely neutralized, as was the case with the *Kaiser Wilhelm der Grosse* last fall. Sailing vessels, by a careful setting and manipulation of the sails, may in many cases be said to be largely independent of rudders, except for working in narrow waters. They may, moreover, being usually relatively small, be readily fitted with "jury" rudders, or some other makeshift device, which answers the purpose of bringing them safely to port.

With single-screw steamers, however, in which by far the largest part of the world's seaborne traffic is carried on, the problem is one of great moment, and anything which deranges the steering mechanism endangers the very safety of the vessel. The bulk of the ship is usually too great to be largely influenced by anything of the nature of a "jury" rudder, and reliance must be had upon meeting another vessel, and being towed into port—large salvage claims being a natural outcome of the situation. The familiar "ounce of prevention" adage is thus seen to be strictly applicable here.

The great importance of the subject is thus apparent, and some of the inherent weaknesses of steering gears are pointed out in our article, in which most of the general types of gear are covered.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

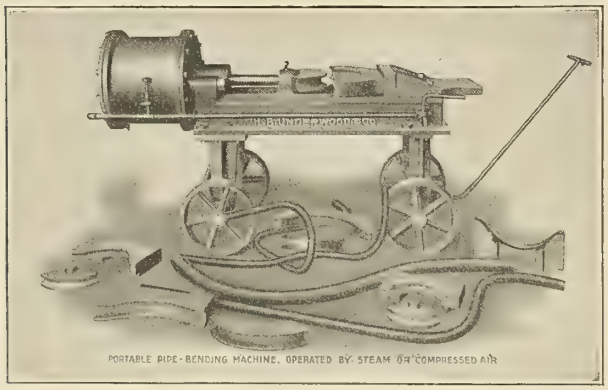
	Tons.	Knots.		Mar. 1.	April 1.
BATTLESHIPS.					
South Carolina..	16,000	18½	Wm. Cramp & Sons.....	39.5	42.2
Michigan.....	16,000	18½	New York Shipbuilding Co.....	45.0	48.6
Delaware.....	20,000	21	Newport News S. B. & D. D. Co	12.77	18.1
North Dakota...	20,000	21	Fore River Shipbuilding Co....	21.4	25.7
ARMORED CRUISERS.					
North Carolina..	14,500	22	Newport News Co.....	98.	99.
Montana.....	14,500	22	Newport News Co.....	94.96	97.
SCOUT CRUISERS.					
Chester.....	3,750	24	Bath Iron Works.....	98.38	99.1
Birmingham....	3,750	24	Fore River Shipbuilding Co....	96.69	99.1
Salem.....	3,750	24	Fore River Shipbuilding Co....	94.31	95.2
TORPEDO BOAT DESTROYERS.					
Number 17.....	700	28	Wm. Cramp & Sons.....	6.88	12.
Number 18.....	700	28	Wm. Cramp & Sons.....	6.8	10.8
Number 19.....	700	28	New York Shipbuilding Co.....	8.4	11.5
Number 20.....	700	28	Bath Iron Works.....	5.38	8.
Number 21.....	700	28	Bath Iron Works.....	4.91	7.8
SUBMARINE TORPEDO BOATS.					
Cuttlefish.....	—	—	Fore River Shipbuilding Co....	99.	99.
Number 13.....	—	—	Fore River Shipbuilding Co....	23.	30.
Number 14.....	—	—	Fore River Shipbuilding Co....	23.	30.
Number 15.....	—	—	Fore River Shipbuilding Co....	23.	30.1
Number 16.....	—	—	Fore River Shipbuilding Co....	16.3	29.9
Number 17.....	—	—	Fore River Shipbuilding Co....	7.5	10.3
Number 18.....	—	—	Fore River Shipbuilding Co....	7.5	10.3
Number 19.....	—	—	Fore River Shipbuilding Co....	7.5	10.3

ENGINEERING SPECIALTIES.

A Portable Pipe-Bending Machine.

This can be driven by steam or compressed air, at 80 to 100 pounds pressure, and will bend iron pipe, cold, up to 2 inches in diameter without filling, flattening or splitting the pipe. It is also claimed that right-angle bends can be made in 2-inch pipe in two minutes or less, thus efficiently doing the work almost as rapidly as the pipe can be fed to the dies.

The piston is forced back on the return stroke by a spiral spring, projecting into a round boss of the cylinder head; the front head and piston rod requiring no packing. The end of the piston rod is supported in a crosshead, which slides in the guides. Six dies are furnished, and include sizes from ½ inch to 2 inches. The dies are easily and quickly changed, the



PORTABLE PIPE-BENDING MACHINE, OPERATED BY STEAM OR COMPRESSED AIR

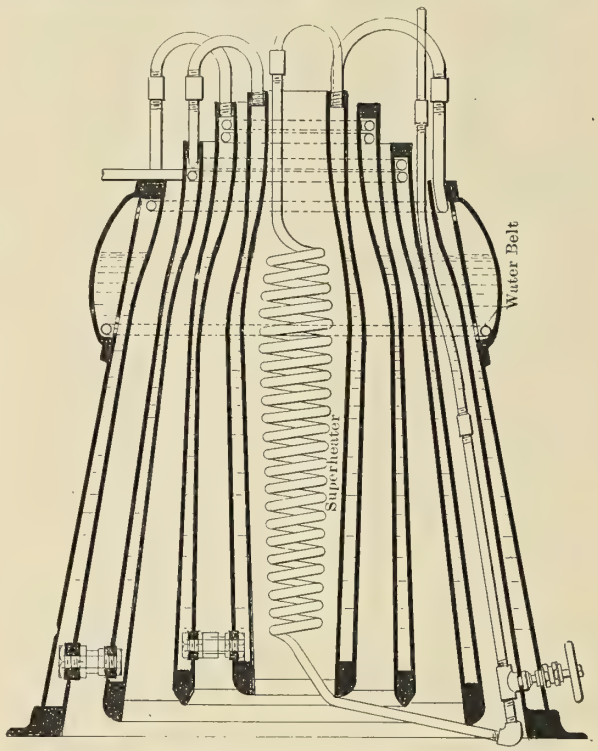
female die being centered by a dowel in the angle plate, which is adjustable along the bed-plate, bolted in place, centered and supported against the thrust of the air piston by large dowel pins. The male die is centered and supported on the end of the piston rod, which projects through the crosshead.

The truck shown in the illustration is an extra addition, and it is one which has proved so useful as to be almost an essential convenience.

This machine was designed especially by H. B. Underwood & Company, 1025 Hamilton Street, Philadelphia, Pa., for general use wherever it becomes necessary to bend pipe.

A Tubeless Boiler.

The odd device illustrated has been developed by G. R. Steward, 28 Victoria street, Westminster. The boiler consists of a series of cones with annular water spaces between and combustion chambers between the water spaces. The section which we show indicates that the two sides of each combustion chamber are thoroughly exposed to the heated gases, so that, with the exception of the outer shell, the entire boiler surfaces may be considered as heating surface. In each of the conical annular spaces the thickest body of water is at the bottom, where the greatest heat is attainable from the fire. The various sides of cones are connected together by hollow stays, acting as passages for steam and water.



Evaporation is very rapid, and in the interests of keeping the water at a constant level, a water belt, outside the main cone of the boiler, is fitted, with direct communication to the outer cone of the boiler for water and for steam. A perforated pipe around the bottom of this reservoir is supplied with live steam for raising the temperature of the water in this section nearly to the boiling point before it enters the boiler. The cones vary in height, partly to give freedom to the gases at the bottom, and partly to give increasing steam space to the inner water chamber before the steam enters the superheater. The latter is composed of a coil of tubing, so arranged that it may be flooded when the fire is first lighted, to prevent burning out. Around the tops of several of the water columns are fitted perforated coils, through which water is passed, and this is flashed into steam on striking the inner sides of the water columns.

From cold water steam was raised, without the use of the flash, in 2 minutes 3 seconds, and a pressure of 150 pounds was reached in 5 minutes 55 seconds from the start. Starting with hot water this same pressure was reached in 2 minutes 55 seconds.

A 10-horsepower boiler of this type, tested in March of this year, had a boiler-heating surface of 30 square feet, a superheater surface of 1 square foot, and a grate area of 1.4 square feet. The ratio of heating to grate area was 21.5 to 1. At a mean boiler pressure of 140 pounds there was evaporated during a four-hour test 608 pounds of water (4.4 boiler horsepower) from and at 212 degrees F., on a consumption of 43 pounds of paraffin (kerosene). This shows an evaporation of

14.1 pounds of water, standard, per pound of fuel. In this case the temperature of the superheated steam was 615 degrees F. Coal and coke have also been used as fuel in this boiler.

A High-Pressure Spiral Piston Packing.

Cobb's piston and valve rod packing, manufactured by the New York Belting & Packing Company, Ltd., 91 Chambers street, New York, is designed especially for withstanding heat

and the highest pressure. The rubber core of the packing is oil and heat proof, acting as a spring or cushion in holding the packing up to the rod. The outer covering is made of material not affected by heat. The lubricants employed are said to be entirely free from grits and acids.

This packing is said not to get hard under any degree of heat, and is furnished either round or square, and either spiral or in straight lengths. When it is first put in, the glands are screwed up with a wrench, to give the packing the proper shape, then two or three turns are put in to compress the packing, the glands are then released again, and finally screwed up by hand until the packing is fully expanded.

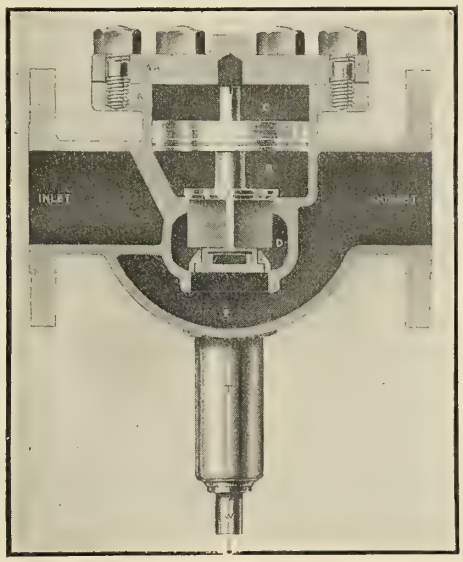
The Collin Steam-Pressure Regulating Valve.

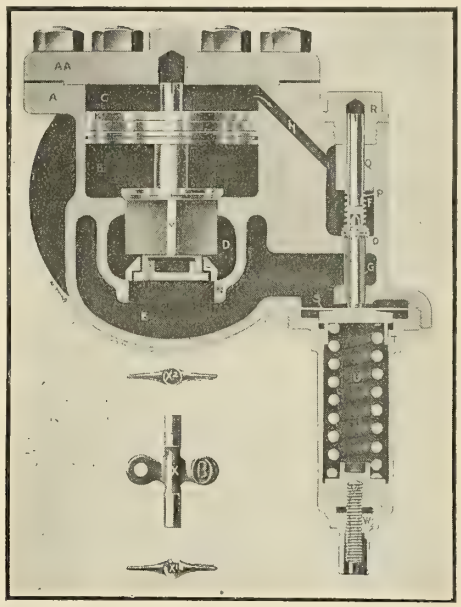
The illustrations are sectional views, at right angles to each other, of this device, type B, made by the Ohio Brass Company, Mansfield, Ohio. Two features to which attention is called are the absence of springs for opening and closing the main valve, and the absence of dash-pots for cushioning; the valve cushions inherently when closing, and is balanced when open, its operation depending upon the pressure of the fluid passing through it. The steam enters the valve chamber *B* in such a way as to distribute its force evenly against the valve. It enters the chamber *C* through a small hole drilled in the main piston *K*.

The spring case *T* carries the regulating spring *U*, which forces the diaphragm *S* upward against the pressure of the outlet side of the valve. The controlling valve chamber *F* connects with the main valve chamber *C* through the regulating port *H*. This chamber contains the controlling valve *G*, which is held to its seat by the pressure and by the spring *P*. At the lower end, the controlling valve is also in contact with the diaphragm.

As soon as the pressure in the outlet or service side begins to drop, the spring *U* forces the controlling valve from its seat, allowing the steam in the chamber *C* to pass through the regulating port to the controlling valve chamber and the outlet *E*. The pressure in the chamber *C* is therefore reduced below that in *B;* the main valve rises and permits steam to pass to the service side. When the pressure on that side has been restored, the diaphragm forces back the regulating spring and allows the controlling valve to seat. As soon as this occurs, the pressure in the chamber *C* builds up, and the main valve *J* starts to close.

Below the main valve, guide wings *M* extend through the

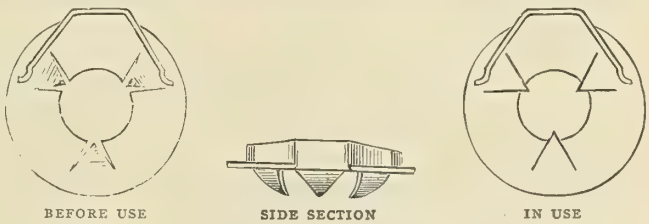




cushioning chamber *D*, and carry a supplementary piston *L*, which enters the port *N* when the valve is closed. When the main valve opens, it lifts beyond a point where steam cutting can occur before the supplementary piston opens its port. This is to prevent the cutting of the main valve and seat. In closing, the supplementary piston enters the port *N*, checking the flow of steam and allowing the main valve to come to its seat against a steam cushion, formed by high-pressure steam in the chamber *D*.

The Fastnut Washer.

This device is placed on the market by Fastnut, Ltd., 60 Aldermanbury, London, E. C., and is particularly designed to hold nuts and screws tight, no matter what the vibration. It has been supplied to the British Admiralty and to many steamships. It is dropped over the bolt, teeth downwards, in place of the ordinary washer, and the action of screwing up the nut flattens the teeth and holds the washer tight to the bolt. The spring flanges on top allow the nut to be turned, but prevent its slacking back. It is not necessary to put an extra strain



on the thread of the nut by screwing up unduly tight, and no cotter pins are required. It goes without saying, however, that the head of the bolt must be thoroughly in place before the "Fastnut" is applied. This washer may be removed, after the nut is unscrewed, by being pried up sufficiently to release the teeth, when it may be unscrewed from the threads without damage to the bolt.

The regular sizes in stock are fourteen in number, varying from 3/16 inch to 1½ inches in diameter of bolt or screw. They are made of brass, and are fitted for either hexagonal or square nuts.

TECHNICAL PUBLICATIONS.

Neuere Schiffsmaschinen. By H. Rosenthal. Size, 7 by 9¼ inches. Pages, 378; figures, 29. Berlin, 1908: Konrad W. Mecklenburg. Price, 10 marks (price of plates, 20 marks; complete work, 30 marks).

In February of 1907 we mentioned the book of plates, 53 in number, measuring 10¾ by 15½ inches, and including a total of more than 1,200 drawings of the various parts of the machinery used on board warships and merchant vessels. The present text covers the same ground as these plates, being explanatory, not only of the drawings in themselves, but also of the methods of obtaining results as exemplified in the finished work. The book is divided into six parts and an appendix, covering, respectively, ships' boilers, the main engines, auxiliary engines and apparatus, steam engines and motors for small vessels, steam turbines and ship construction, the latter item being very brief. The entire work is descriptive, there being practically nothing of a theoretical nature involved, and such illustrations as are used in the text are simply small sketches to supplement the more important illustrative material in the book of plates.

The work is well printed, and may, we presume, be fully relied upon for the ground which it covers.

Practical Shipbuilding; a Treatise on the Structural Design and Building of Modern Steel Vessels. By A. C. Holms. Text, 5¾ by 9⅜ inches. Pages, 638. Plates, 15¾ by 12½ inches, 115 in number. London and New York, 1908: Longmans, Green & Company. Price, 30s. net and $10.00 net.

This is the second edition, in two volumes, of a work which first appeared about four years ago. The text has been revised and some new matter added. During the four intervening years, however, neither the structural design of steam vessels nor shipbuilding practice has undergone any marked alteration. In a number of minor details, processes and appliances there has been alteration, and it is to take care of these items that the revision has been made. Two new plates are added to the volume of illustrations (there are no illustrations whatever in the text), and the work is believed to be now entirely up to date.

The text is divided into two parts, of which the first deals with the design and arrangement of the various items entering into the structure of the ship, and covers about 450 pages. The second part deals with the operation of the drawing office and mold loft, and with the work as performed in the shipyard of bending the frames, making and using templates and the various parts of the general work of handling and working the materials and building a ship. An appendix, dealing with elementary considerations on the strength and stiffness of beams, is followed by an unusually complete index, covering some 30 pages.

Throughout the work the rules of *Lloyd's Registry* are frequently mentioned, and are taken in general as the standard of constructive practice, though occasionally variations are introduced to conform to the practice of the British Corporation and the Bureau Veritas. Theoretical discussion, involving higher mathematics and mechanics, has been avoided, although, of course, the results of such investigations are freely made use of as established facts. This renders the work much more valuable to the general reader, though detracting somewhat from its value to the special investigator; in the interests of limiting the size of volume, however, this method has been considered preferable to using a large amount of material which the ordinary reader would not need. To assist the investigator numerous foot notes refer him to the original sources of the information presented, so that the theoretical features of the various problems involved may be followed out in this manner.

Throughout the work boldfaced catch heads have been used to call attention to the main items in the several paragraphs, and free use is made of references back and forth between the text and the plates. The latter, while entirely of the zinc pattern (except for a few half-tones illustrating shipyard tools) are very clear and well reproduced. They include details of every part of the ship's structure, as well as general drawings, showing the arrangement of the principal compartments on ships of various types, the expansion of shell plating, the development of water lines and buttocks, and even such details as masts and rigging in steam and sailing vessels. The amount of information included is enormous, and the book is an exceedingly valuable portion of our literature on this subject.

Profit Making in Shop and Factory Management. By Charles U. Carpenter. Size, 5¾ by 8½ inches. Pages, 146. New York and London, 1908: *The Engineering Magazine.* Price, $2 (8s. 6d.)

This work is a concise expression of the methods which the author has developed in connection with the National Cash Register Company and the Herring-Hall-Marvin Safe Company, of which latter he is president. The contents appeared first in the form of a series of articles in *The Engineering Magazine* during 1907. They have been carefully revised, somewhat enlarged and rearranged, and now divided into chapters. The work was produced in the midst of the author's labors in the management of a great manufacturing company, and was inspired by his keen interest in the promotion of better ideals in industrial organization.

It is divided into fourteen chapters, covering, respectively, the reorganization of run-down concerns; the practical working of the committee system; the necessity for reports and their uses; the designing and drafting department; the tool room; minimizing the time of machine tool operations; the use of high-speed steel; the determination of standard times for machine operations; standard times for handling the work; standard times for assembling; stimulating production by the wage system; stock and cost estimates; the upbuilding of a selling organization, and effective organization in the executive department.

The work takes up the defects in the various departments and methods of overcoming difficulties of this character; and is illustrated simply by tables or forms for cards for recording work in its various processes through the shop. Stress is laid upon the importance of putting the work in control of competent men, no matter what salary may be demanded. It is shown to be more expensive, in the long run, to employ an incompetent man at a low salary than a thoroughly competent man at several times this figure. The whole keynote seems to be the obtaining of the best efficiency from every unit in the works, whether that unit be human or a machine built of iron and steel.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

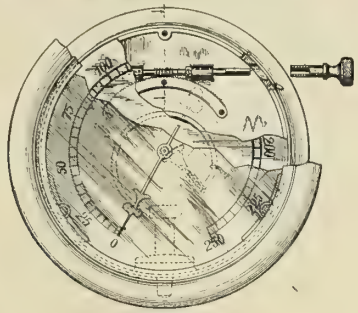
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

880,018. APPARATUS FOR RELEASING SHIPS' BOATS. JOSEPH FORCIER, SEATTLE, WASH.

Claim.—An apparatus for launching boats comprising means for lowering and holding a boat suspended in a lowered position, bases secured in opposite end portions of the boat, catch members pivoted to said bases for engaging said means, spaced uprights fixed to said bases, shafts supported for rotation in said uprights, keepers fixed to said shafts for holding said catch members against swinging, said keepers projecting from the outer ends of said shafts, a shaft rotatably supported beneath said first named shafts and provided with an operating handle, arms fixed to the other ends of said first named shafts, arms fixed to the last named shaft, and links connecting the arms of said shafts. One claim.

873,034.—STEAM OR VACUUM GAGE. JAMES ELY, 85 CHAMBERS STREET, NEW YORK.

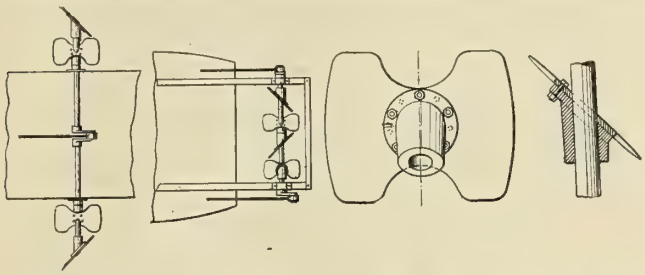
Claim.—In a steam gage, the combination with a casing, a rotatable indicating hand and means for rotating same in the operation of the device, of a rotatably mounted scale carrying disk, means arranged



within the casing for rotatively adjusting same and for locking the disk in its adjusted position, and a removable key by which access may be had to such adjusting means from the exterior of the casing. Three claims.

880,353. PADDLE WHEEL. OTTO BROWN, SACRAMENTO, CAL.

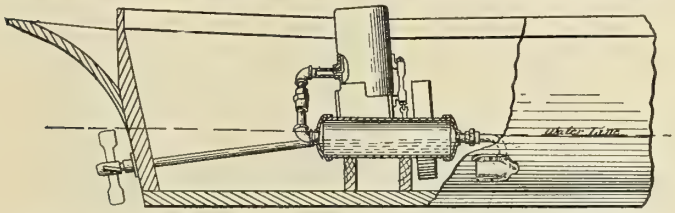
Claim 2.—In a propelling device for vessels, the combination of propelling blades arranged in pairs, each pair composed of two sets of blades



disposed on opposite sides of a common shaft in alternate manner, and with the blades of the same at an oblique angle and in contrary position to the blades of the other set, said blades being adjustable at varying angles with respect to the axis of rotation. Two claims.

880,604. EXHAUST MECHANISM FOR EXPLOSIVE ENGINES. J. M. AND E. E. TRUSCOTT, ASSIGNORS TO TRUSCOTT BOAT MANUFACTURING COMPANY, ST. JOSEPH, MICH., A CORPORATION.

Claim 3.—In combination with a boat having an explosive motor mounted thereon, exhaust mechanism for the motor, comprising an expansion tank having communication with the exhaust pipe of the motor,

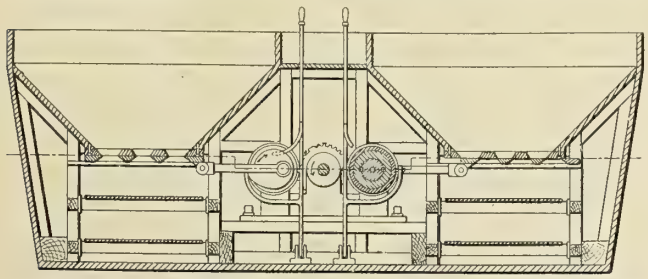


a part of said tank being located below the waterline, and an outlet pipe leading from the tank and extending through the bottom of the boat below the waterline thereof, the discharge end of said outlet pipe being free and unobstructed, and directed toward the stern of the boat. Eleven claims.

880,895. BOAT-DETACHER. ERIK H. LINDMAN, SAN PEDRO, CAL.

Abstract.—The invention relates to means for securing and releasing boats, and has for an object to provide means whereby the boat may be automatically released by the action of the water in case of a vessel sinking; or by which the boat may be quickly released by hand whenever desired. Six claims.

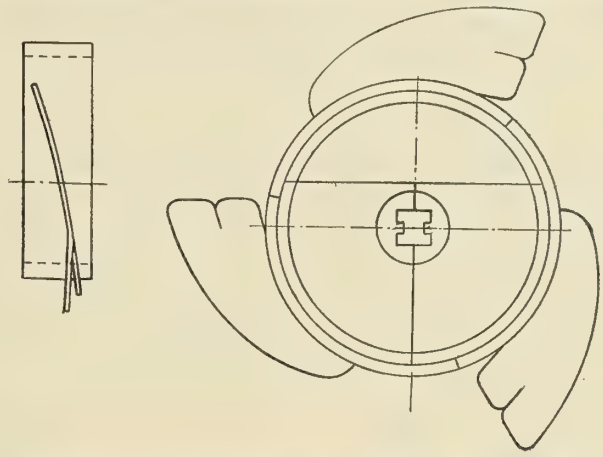
881,446.—APPARATUS FOR UNLOADING VESSELS. AARON SCHWARTZ, BOSTON, MASS., ASSIGNOR TO AUTOMATIC RAPID UNLOADING COMPANY, BOSTON, A CORPORATION OF MASSACHUSETTS.



Claim 3.—In a movable carrier for sand, coal, and similar material, the combination, with a belt conveyer, of a hopper located with its discharge outlet above said conveyer, two slotted plates at said discharge outlet, one fixed and the other slidable, the walls of the slots therein being so inclined that the material will be cut through by the reciprocation of said slidable plate to effect a delivery; and means for reciprocating said slide. Ten claims.

881,393.—SHIP PROPELLER. CARL J. H. FLINDT, COPENHAGEN, DENMARK.

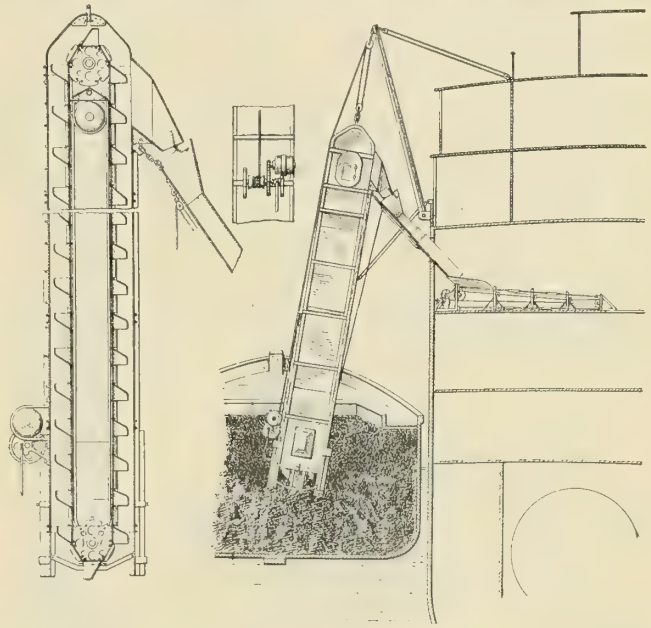
Claim.—A propeller, comprising a shaft, a hub thereon, and wing-shaped propeller blades, each provided with an arc-shaped flange por-



tion attached to the hub with which flange portion the blade is in contact throughout approximately the entire length of its inner edge, the broad ends of the blades being split in the direction of their movement, and the portion between the split and the hub having an angle to the axis of the shaft comparatively smaller than the angle of the outer portion. One claim.

881,429.—APPARATUS FOR COALING VESSELS. LOUIS A. DE MAYO, OF NEW YORK, ASSIGNOR TO DE MAYO COALING COMPANY, NEW YORK, A CORPORATION OF NEW JERSEY.

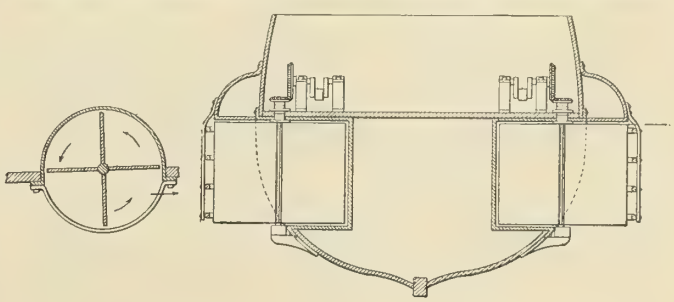
Claim 1.—In an apparatus for coaling vessels, the combination of an



elevator, a boom adapted to be secured to a vessel, a tackle adapted to be secured to the boom and to the top of the elevator, and a winding mechanism mounted on the elevator and connected with the fall of the tackle. Nineteen claims.

881,537. MEANS FOR PROPELLING SHIPS. WILLIAM BETHANY, MARS, ARKANSAS.

Claim 1.—In propelling means for a ship, a casing of semi-circular form within each side of the ship, forming a chamber having an extended top about at the waterline, and its open side in the plane of the outer wall, the flooring of the vessel and the top of the casing forming

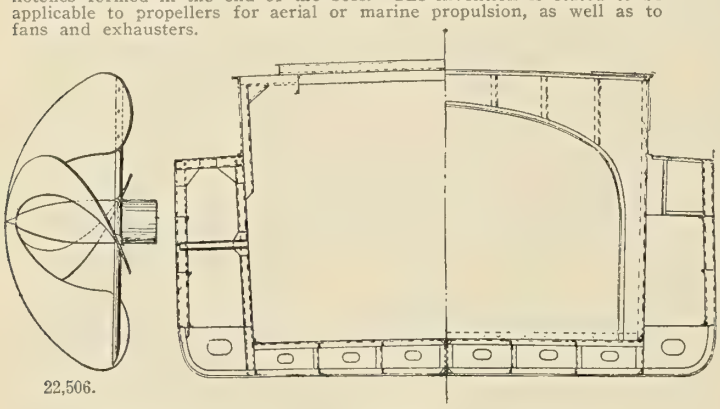


a double wall, a chambered hood secured to the ship's side and connected to the outer edge of the extended top of said casing and forming a watertight chamber overhanging the open side of the casing, and a propeller suspended by the flooring and supported in a bearing at the outer wall of the ship, and means for rotating said propeller. Two claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London. W. C.

22,506. SCREW PROPELLERS; FANS, ETC. W. BEEDLE, ROATH, CARDIFF.

In screw propellers having blades that meet at the geometrical axis of the boss, and are supported by arms connected to the boss, the blades are respectively united one to the other across the axis of the propeller, so that their edges are continuous. The surface of the blades is reduced in width towards the center, where they are supported within notches formed in the end of the boss. The invention is stated to be applicable to propellers for aerial or marine propulsion, as well as to fans and exhausters.



22,506.

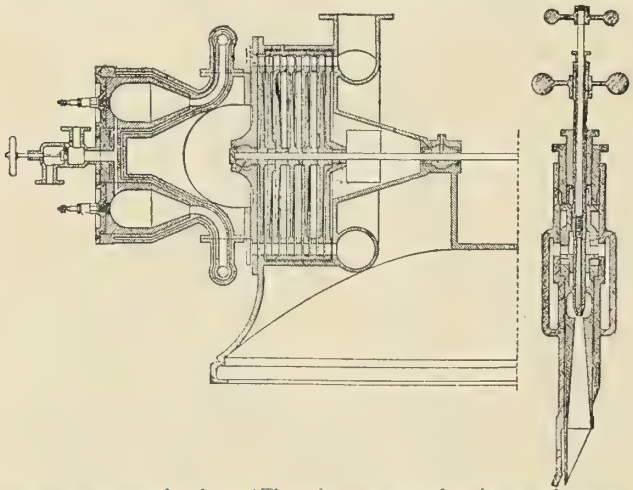
23,680.

23,680.—SHIPS. G. B. HUNTER, WALLSEND-ON-TYNE.

Sectional ships are constructed with detachable buoyant side portions extending to the bottom of the hull, to adapt them for passage through locks and canals of smaller dimensions than the ships. The width of the main portions of the hull is determined by the available width of the canals and locks, the sides are sloped to correspond with the lock walls, and the bottom is made double and utilized for water ballast. The side portions are adapted to form water-ballast tanks, and also to be detached when it is desired to float the vessel in sections through the lock. The main parts of the ship are temporarily secured by bolts, rivets, etc., the various parts being separated when required by careening.

23,074. ELASTIC-FLUID TURBINES. C. WEDEKIND, ST. JEAN SUR MER, FRANCE.

The arrangement described comprises charging apparatus, explosion chambers, and nozzles adapted to deliver the products of combustion of any combustible gas to the blade passages of a parallel-flow turbine. Air is admitted to the charging-chamber by a pipe, and gas by openings



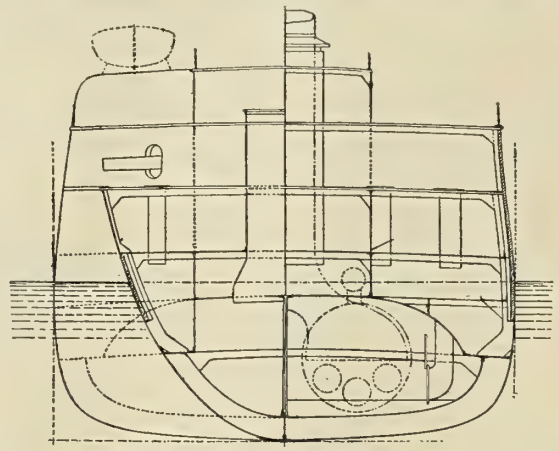
from one or more chambers. The mixture passes by pipes to the second combustion chambers, which are constructed of refractory material and are of any suitable shape. The securing plates and sparking plugs of such chambers are grouped round the charging apparatus. Cooling water may be circulated in the casing chamber, and may produce steam. A hollow needle, operated by a hand wheel, regulates the opening, and the small nozzle at the tip of the needle is itself regulated by another needle worked by a wheel. Steam from the water jacket enters and assists the gas in the nozzles.

23,123. ELASTIC-FLUID TURBINES. P. GHELLI, AVELLINO, AND C. G. CAZZANI, SAVONA, ITALY.

In a gas turbine, atmospheric air is caused to pass through the following cycle: (1) isothermal compression; (2) heating at constant pressure in a regenerator; (3) isothermal expansion in a turbine; and (4) cooling at constant pressure in the regenerator. The heat energy of the combustible gases, corresponding to the work done by the engine, is added during the third stage of the cycle. The turbo-compressor, arranged end on to the driving turbine to balance end pressure, is provided with a perforated casing and annular chambers from which water is delivered as spray. In this way, heat of compression is absorbed. The compressed air passes through the pipes of the regenerator and then an automatic regulating valve to the turbine. The combustible gases are introduced from the annular chambers through openings in the casing, and the temperature is sufficiently high for ignition to be spontaneous. The exhausting mixture of air and combustion products at a high temperature passes by a pipe to the regenerator, and there parts with its heat to the incoming air. The form of the regenerator and the method of transferring heat may be varied. Liquid or gaseous combustible is drawn from a reservoir and compressed by a pump, and is forced through pipes in the interior of the regenerator, where it is vaporized if necessary, and heated.

23,834. SHIPS' BULKHEADS; COMPARTMENTS. J. J. F. ANDREWS, OLD CHARLTON, LONDON.

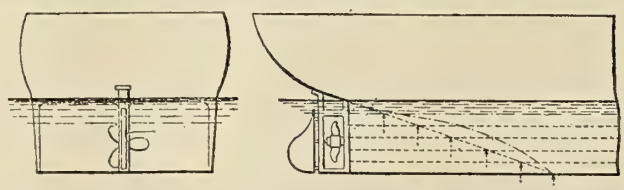
Two watertight decks extend right across the ship, one being above, and the other below, the waterline. The lower deck is curved or carried down to the sides of the vessel to meet the lower deck stringer. In addition, longitudinal watertight bulkheads are fitted, partial bulk-



heads being worked between the watertight decks. The spaces at the sides may be utilized as coal bunkers. The construction may be applied to battleships and cruisers, and to mail and passenger vessels.

22,689. SHIPS' HULLS. A. HUBER, WEIDENBACH, COLOGNE, GERMANY.

In a ship with a flat bottom, having a rearwardly-ascending flattened portion of uniform breadth starting at a suitable distance from the



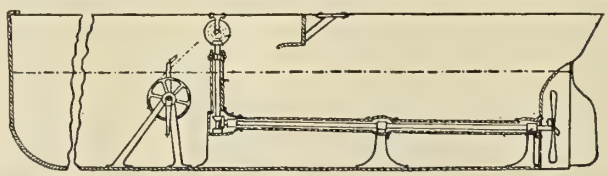
stern frame, the sloped part, which is straight, curved, or of any other suitable section longitudinally, is flattened in cross section, and extends to the full width of the ship. The water, as it passes from beneath the ship, fills the space forward of the propeller and tends to help the ship forward by its pressure on the sloping surface. To prevent water from streaming laterally into the gap, the sides of the ship are extended downward to form side walls, upon which propellers may be carried.

24,332.—SHIPS. A. H. HAVER, NEWCASTLE-ON-TYNE.

The hull is built with a longitudinal underwater projection on each side, the section of which is of greater dimensions parallel to the ship's side than at right angles to it, and is smoothly curved so as to interfere little with any vertical movement. The projection may extend in straight or sinuous lines wholly around the vessel, or it may be confined to certain parts. The different forms of projections may be made integrally with, or attached to, the hull. They may be hollow and built up of plates; in smaller vessels, pneumatically-inflated projections can be used. They may be wholly or partly filled with cork, wood, or any solid or liquid filling. They act as stiffeners to the hull against hogging, sagging and crushing strains.

24,558.—DRIVING-GEAR FOR SCREW PROPELLERS. E. MASSON, GRAVELINES, FRANCE.

Relates to the propulsion of navigable vessels of that class in which the stuffing-boxes for the propeller shafts are dispensed with, the shafts



rotating in tubes open to the water. The mechanism, which is driven by a sprocket-wheel provided with cranks and pedals, consists of bevel pinions, driving a vertical shaft, housed in a tube, and a horizontal shaft, through bevel gearing. The horizontal shaft is mounted in bearings above which are fitted inspection doors. The vertical shaft is carried by an adjustable bearing, regulated by screws fixed to the tube, and a footstep bearing. All bearings are either roller or ball bearings.